

Spray Drift from Banded and Regular Spot Applications

Michael Bird, David Patterson

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Classification: PUBLIC

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Agenda

1. Motivation

- There is a need for refined estimates for spray deposition for precision application

2. Methods

- Simple Banded and Regular Spot
- BRASS: Per-field drift estimates

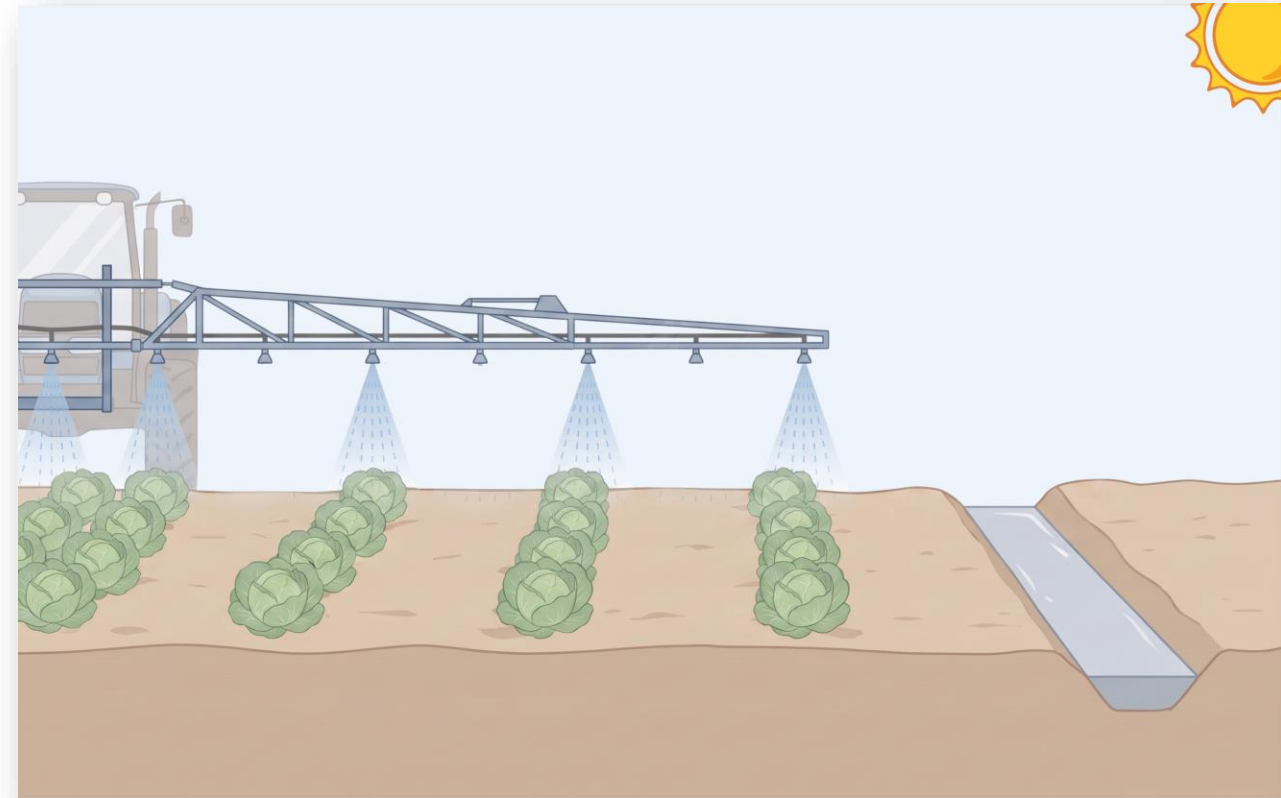
Motivation

Motivation: Spray Drift in PA

Problems

- In the current EU Surface Water Risk Assessment (R.A.), there is no agreed way of reducing spray drift estimates for banded applications
- Runoff and Drainage estimates can scale loading by % of full field application, but Spray Drift uses full field application rates
- If Spray Drift drives your R.A.:

Full Field R.A. = Precision App. R.A.



Banded applications, striped spray:

- Fungicide application spray the crop
- Nonselective herbicide application spray the soil between

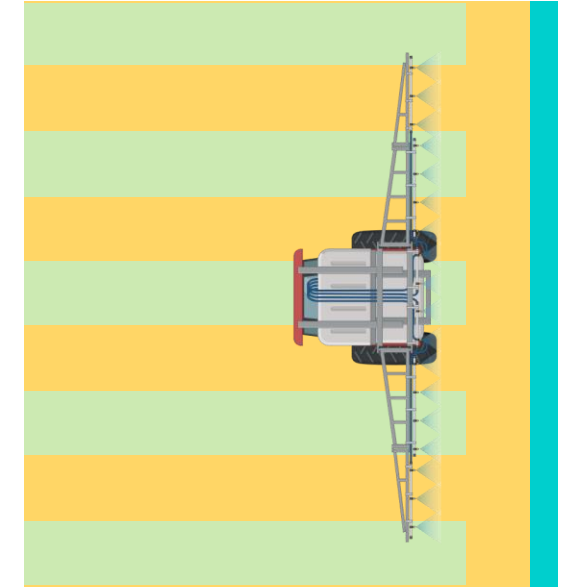
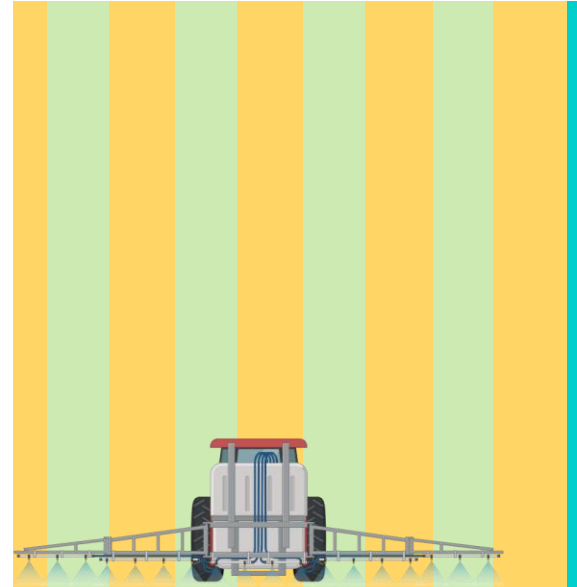
Methods – Simple Banded and Regular Spot

Methods - Objectives

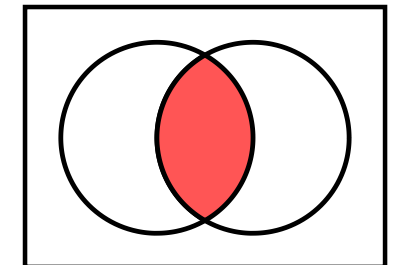
- Can we:
 - Estimate Spray Drift to Banded and Regular Spot applications
 - Make a “drift curve agnostic” approach
 - Calculate drift without having to limit to a fixed resolution.

Row (Spray)
Inter-row (No Spray)
Water body

**Banded
(parallel)**

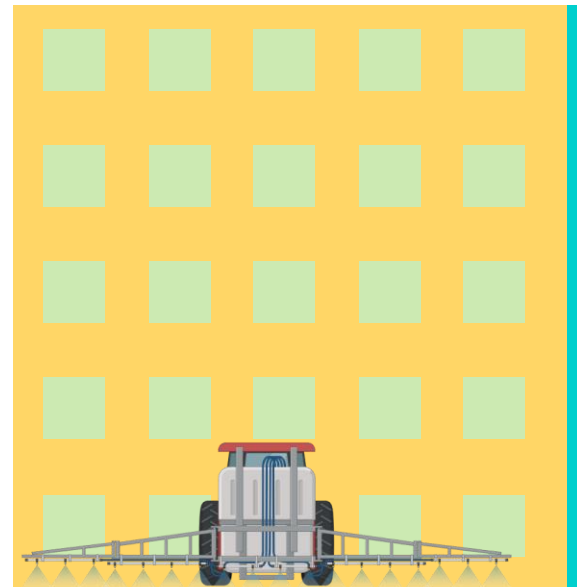


**Banded
(perpendicular)**

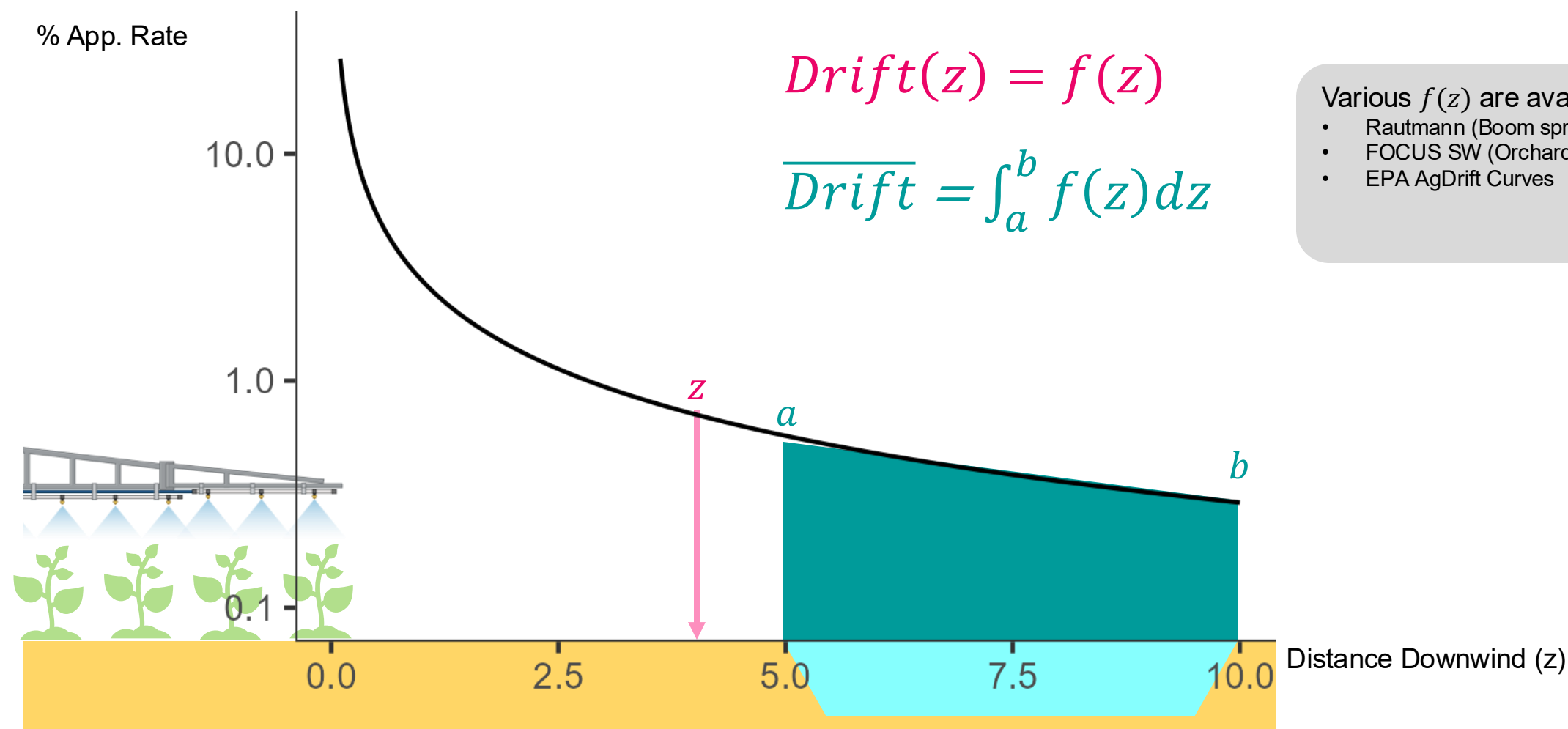


Regular Spot application is the intersection of parallel and perpendicular banded application

**Regular
Spot**

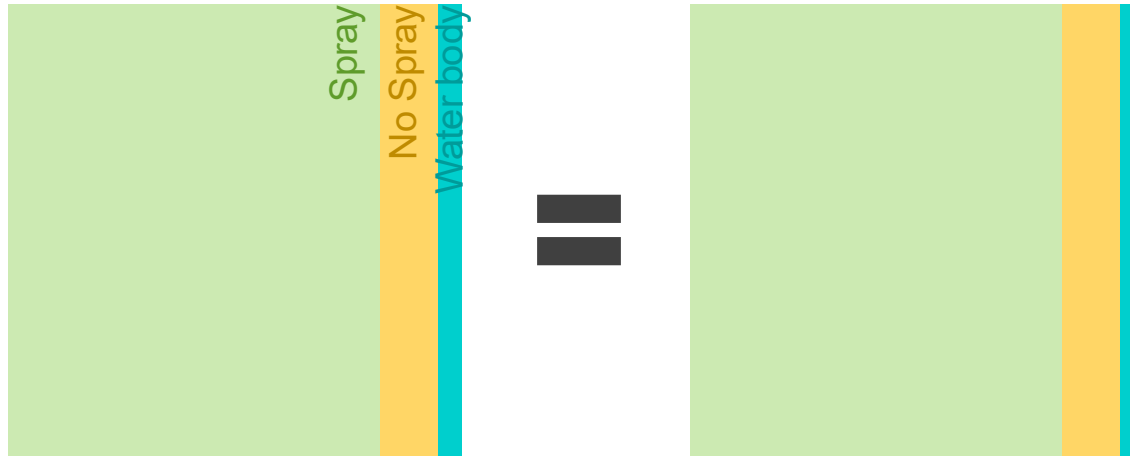


Methods – Drift Deposition Curves



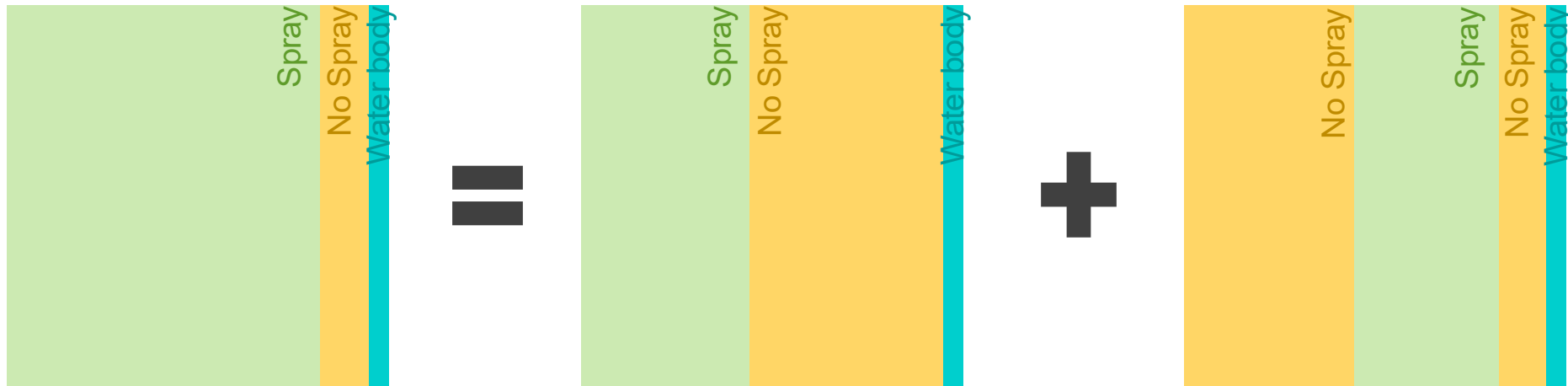
Methods – Fundamental assumptions

*Spray deposition from a full-field application equals the sum of deposition from its individual field segments**

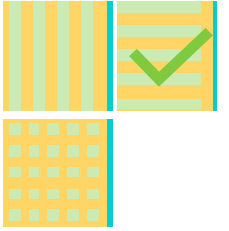


Methods – Fundamental assumptions

*Spray deposition from a full-field application equals the sum of deposition from its individual field segments**

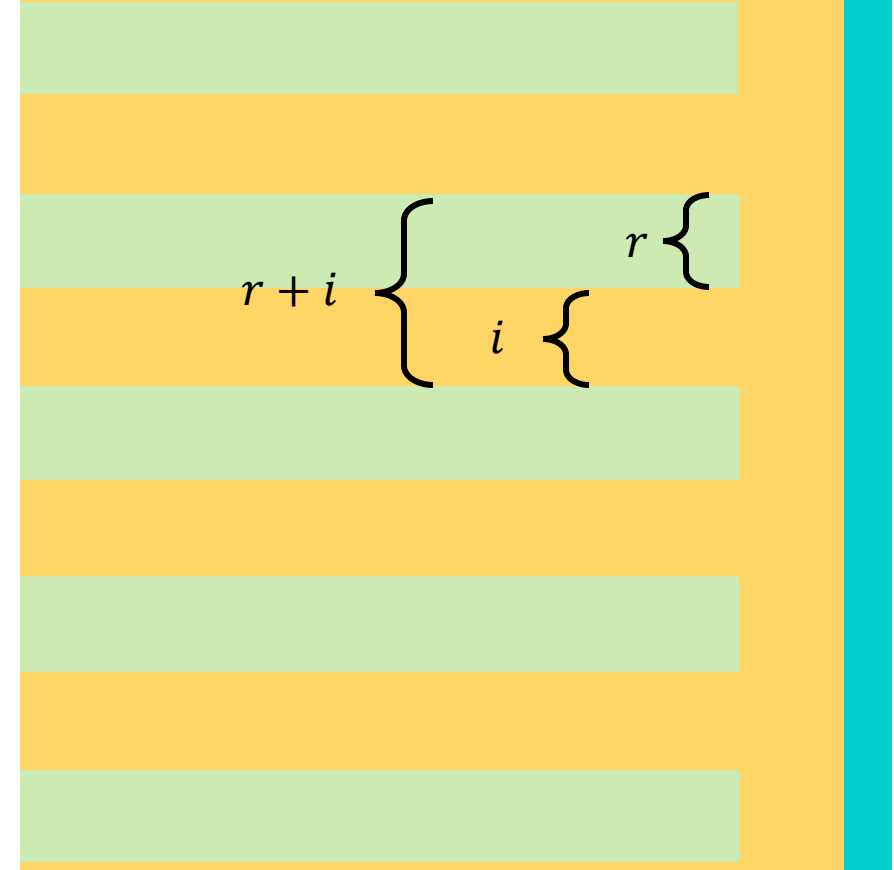


Methods – Simple Perpendicular Band, established idea

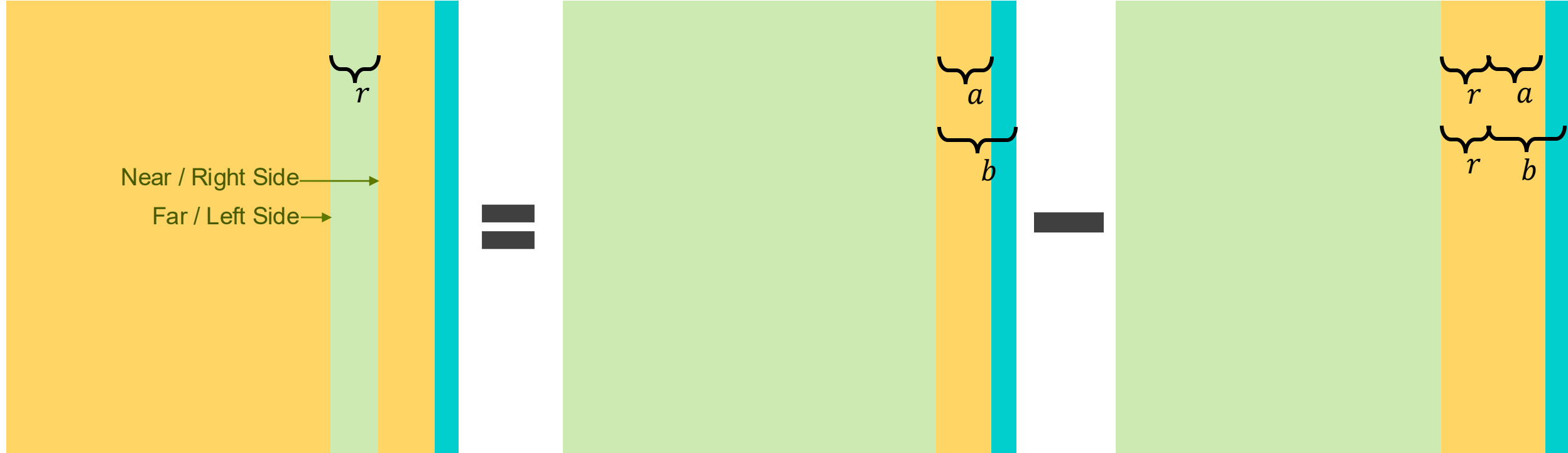


- Assume diffusion and water movement will lead to spray deposition to water body will be well mixed.
- Scale deposition by % of vertical slice sprayed

$$\overline{\text{Perpendicular Banded Drift}} = \frac{r}{r+i} \overline{\text{Full Field Drift}}$$



Methods – Simple Parallel Bands, Novel Idea



Single Band (fixed row width r)

Broadcast Application (Full Field)

Broadcast Application (Offset by row width)

$$\overline{Drift} = ?$$

$$\overline{Drift} = \int_a^b f(z) dz$$

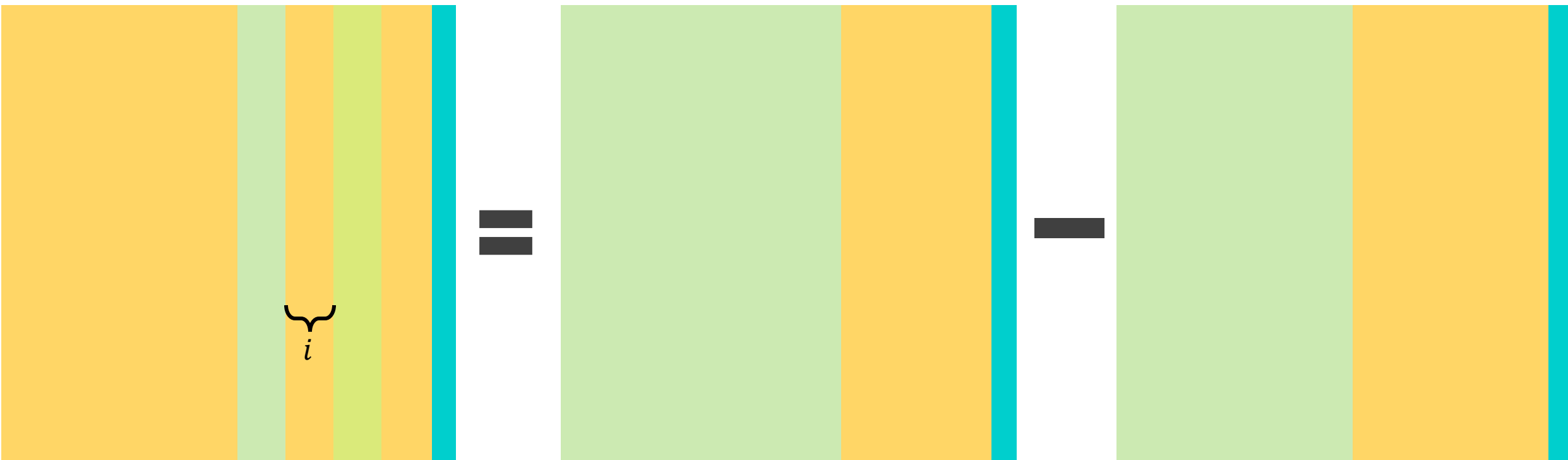
$$\overline{Drift} = \int_{a+r}^{b+r} f(z) dz$$

$$\overline{First\ Band\ Drift} = \int_a^b f(z) dz - \int_{a+r}^{b+r} f(z) dz$$

Near / Right Side

Far / Left Side

Methods – Simple Parallel Bands, Novel Idea



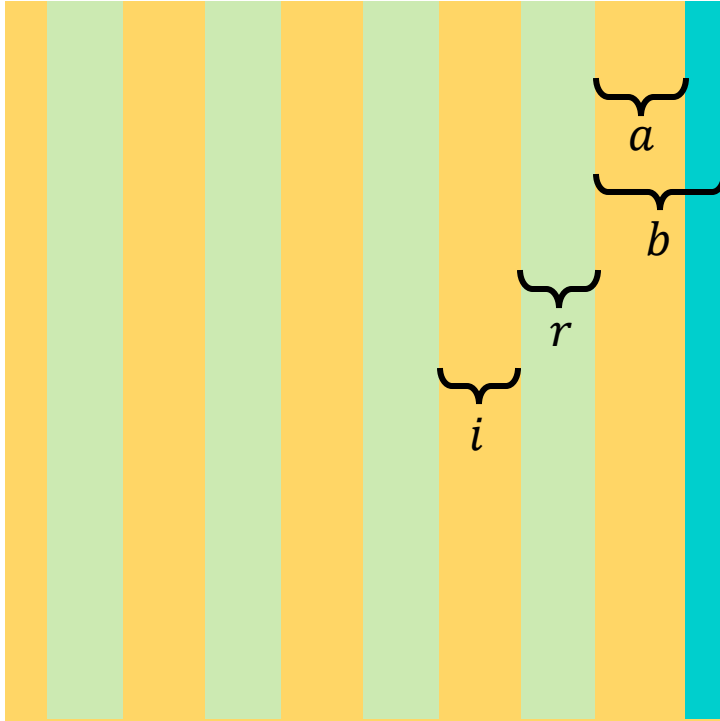
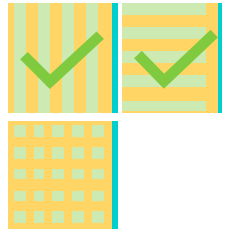
$\overline{Drift} = ?$

$\overline{Drift} = \int_{a+r+i}^{b+r+i} f(z) dz$

$\overline{Drift} = \int_{a+2r+i}^{b+2r+i} f(z) dz$

$\overline{Second\ Band\ Drift} = \int_{a+r+i}^{b+r+i} f(z) dz - \int_{a+2r+i}^{b+2r+i} f(z) dz$

Methods – Simple Parallel Bands, Novel Idea



Variable Summary

- $f(z)$ is the drift deposition at distance z downwind from field edge
- a is the distance from the edge of field to the near edge of water body
- b is the distance from the edge of field to the far edge of the water body
- r is the row width (spray)
- i is the inter row width (no spray)
- j index's each band from nearest to the water body

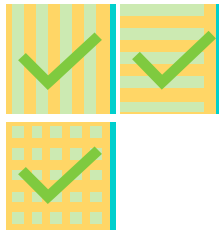
Parallel Banded
Drift

$$= \sum_{j=1}^{\infty} \left(\int_{a+(j-1)(r+i)}^{b+(j-1)(r+i)} f(z) dz - \int_{a+jr+(j-1)i}^{b+jr+(j-1)i} f(z) dz \right)$$

Near / Right Side

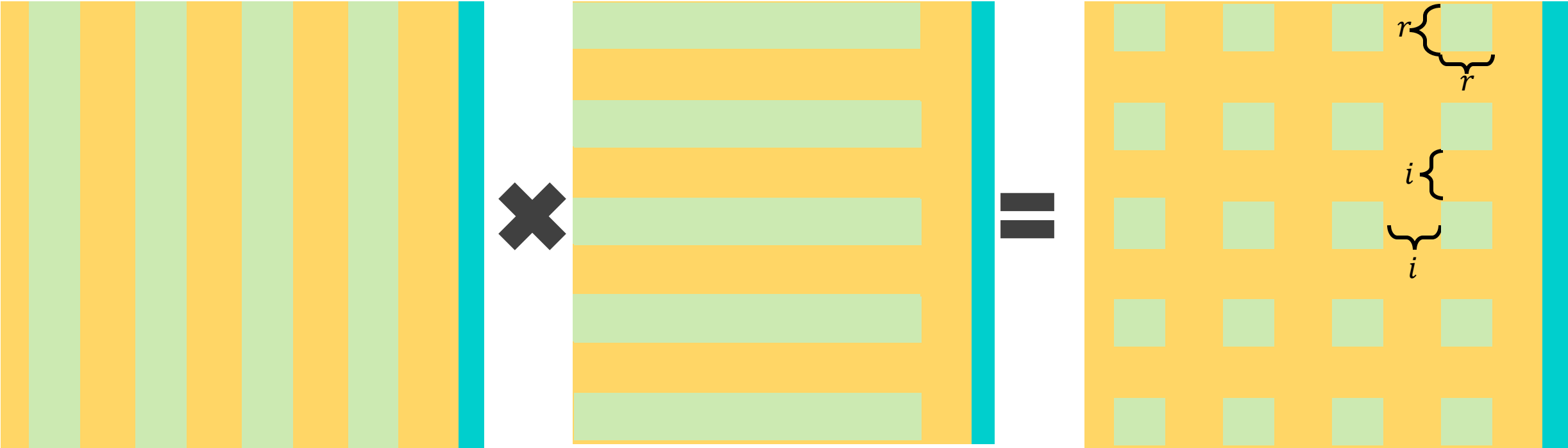
Far / Left Side

Methods – Simple Regular Spot, Combine Parallel and Perpendicular



- Scale drift from each Parallel banded by factor derived from Perpendicular banded

$$\overline{\text{Regular Spot Drift}} = \left(\frac{r}{r+i}\right) \overline{\text{Parallel Banded Drift}}$$



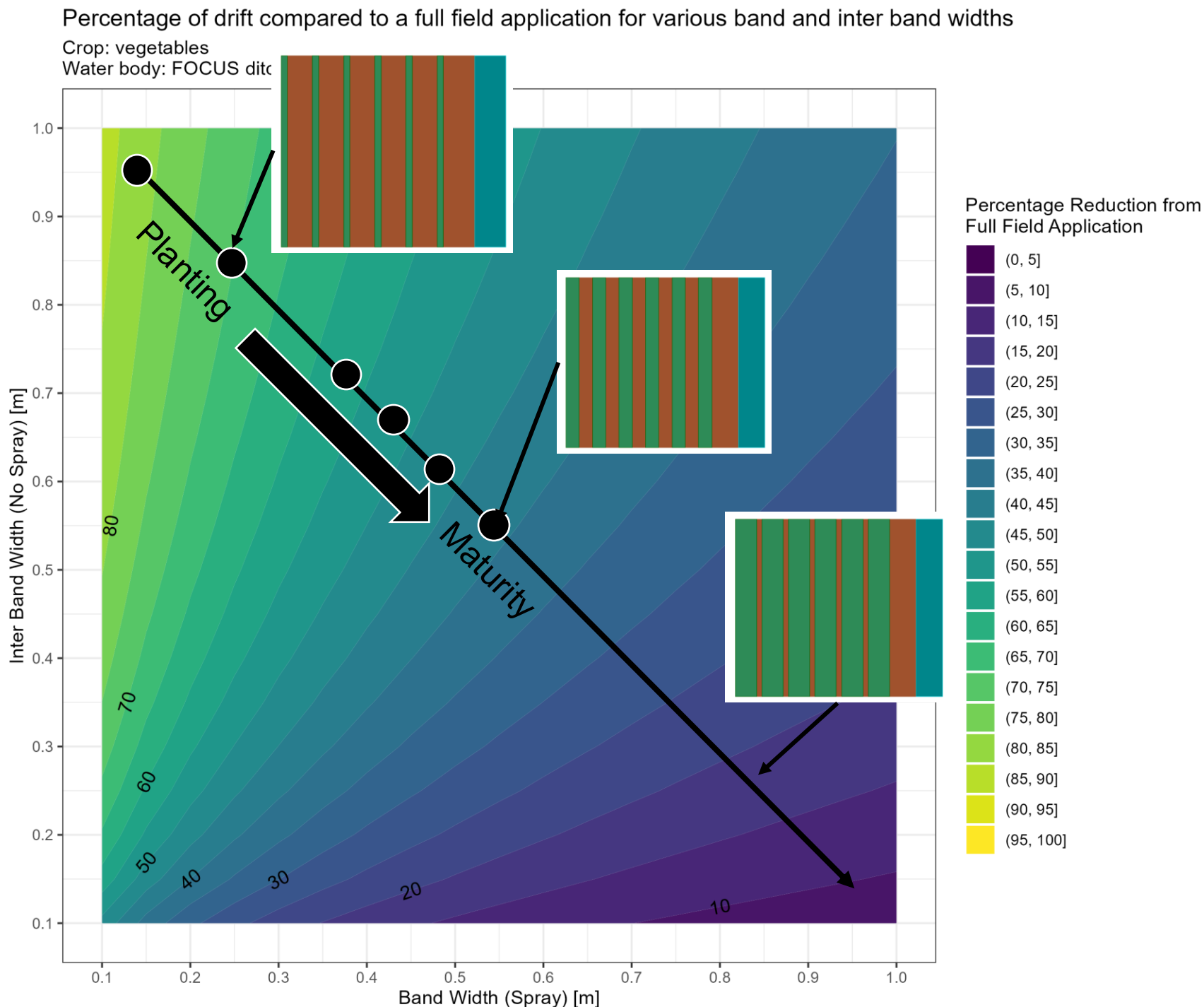
Exploration

Details

- **Rautmann Curve:** “Arable and veg sub 50cm”
- Water body: “FOCUS Ditch”
- Distance from crop to water body 1 m

Insight

- Over growing period, the distance between planted rows d is constant: $r + i = d$ hence $i = d - r$ a straight line.
- Over the growing period,
 - We move down the line
 - The spray drift approaches full field.



Simple Banded and Regular Spot - Explore yourself

- Open-Source R Shiny app developed to enable exploration of potential spray drift reduction using these methods.
 - [Web App](#)
 - [Github Link](#)
- Try it yourself



Web App QR

http://127.0.0.1:7552 Open in Browser Republish

Precision Ag Drift Refinement

Spray Setup
Choose a field option

☒ Full Field
☐ Single Band
☐ Multi Band
☐ Regular Spot

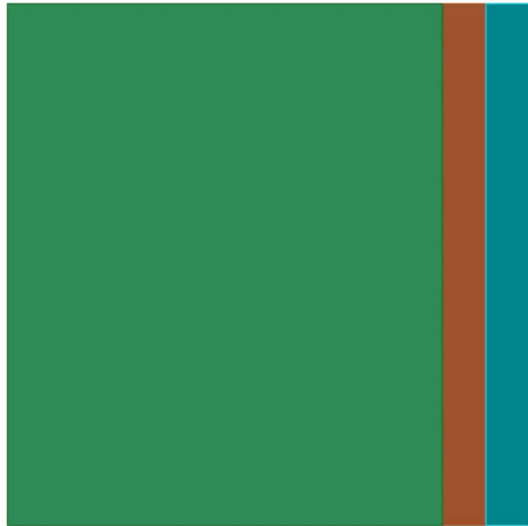
Band Info

Band width (Spray) [m]:
Inter band width (No Spray) [m]:

Field Info

Crop:
Water Body:

Mitigation info
Add a spray buffer:



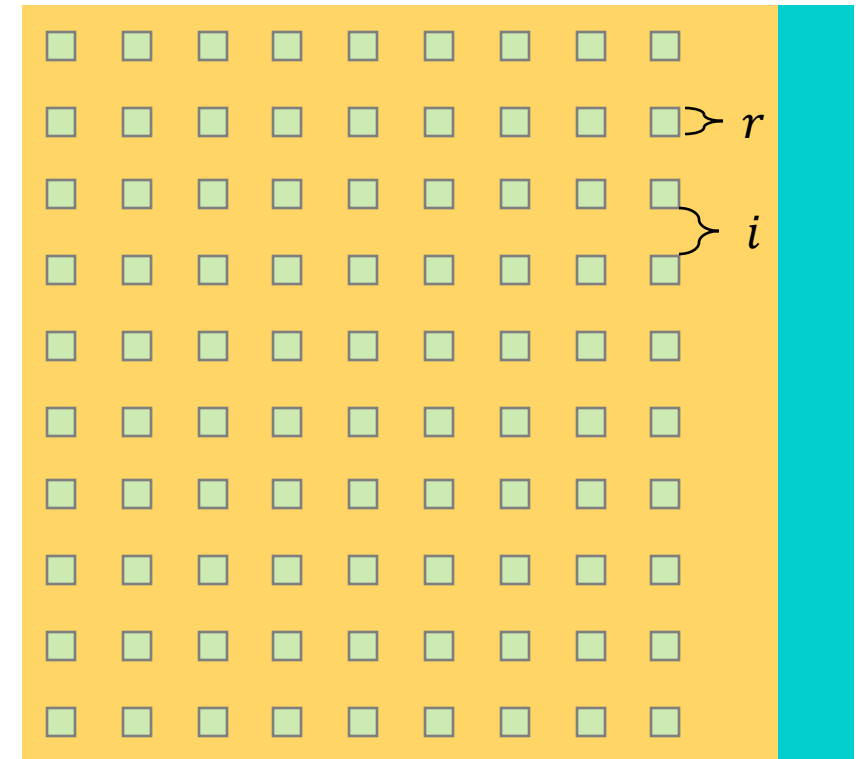
Mean drift deposition over water body: 1.93 % of application rate
Percent reduction over full field application: 0 % reduction

Drift calculations are done over an infinitely long and 1km deep field This is currently just an exploration tool developed by Michael Bird at Syngenta. Not to be used in a real RA ... yet

Methods – BRASS

Method - BRASS

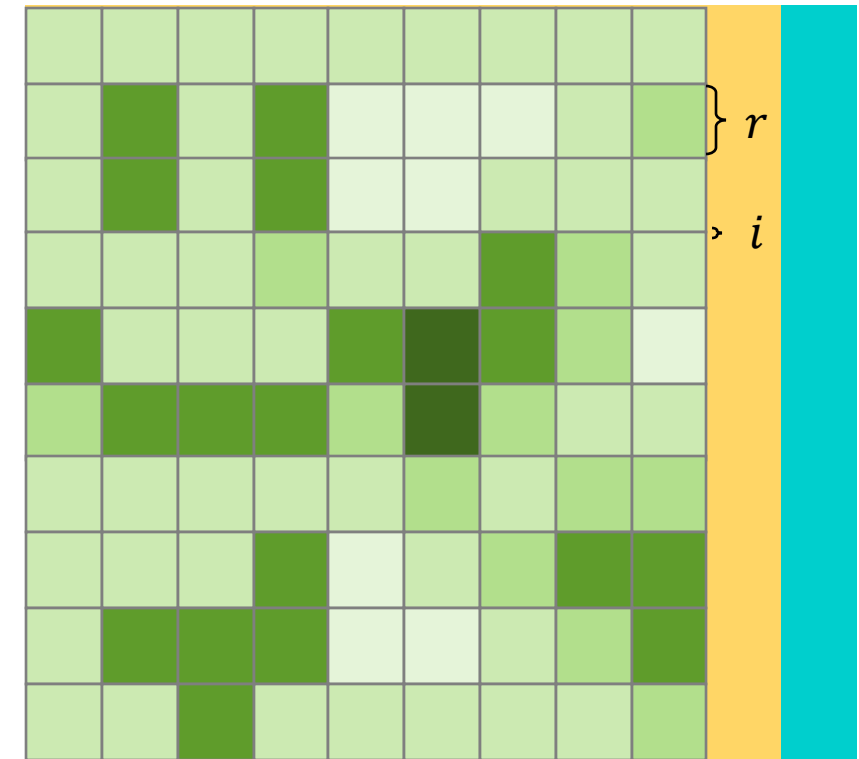
- **BRASS** is a new proposed method for estimating spray drift deposition from spray intensity maps for arbitrary geometries.



Method - BRASS

- Expand the spots so they touch for per pixel estimate (set $i = 0$)
- Calculate total spray deposition as

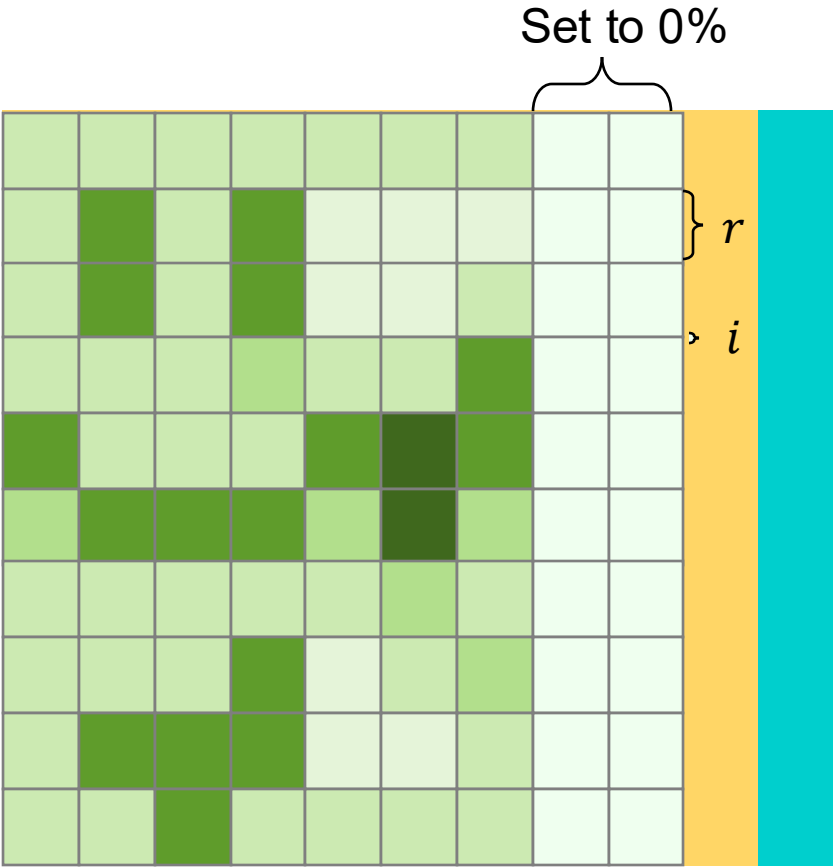
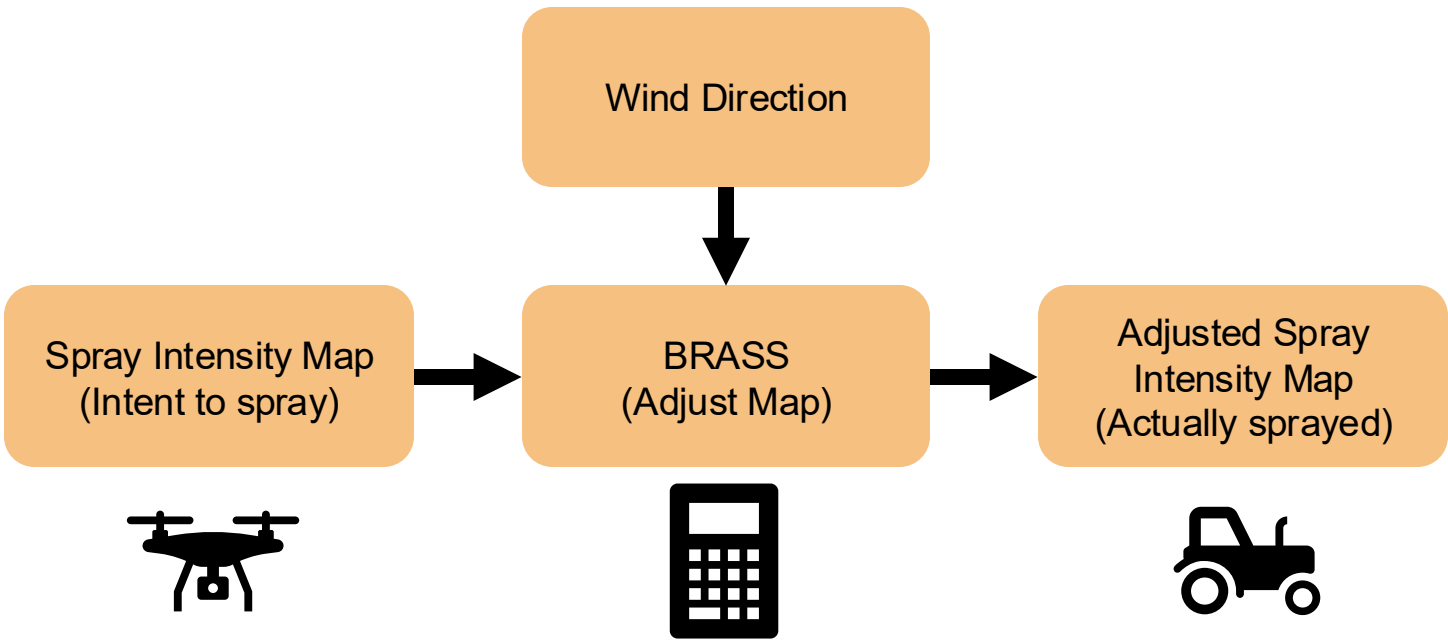
$$\overline{Drift} = \sum FF AppRate \times Spray Intensity \times Drift Perc. per pixel$$



Spray Intensity measures from 0% (**Light Green**) to 100% (**Dark Green**) of Full Field rate

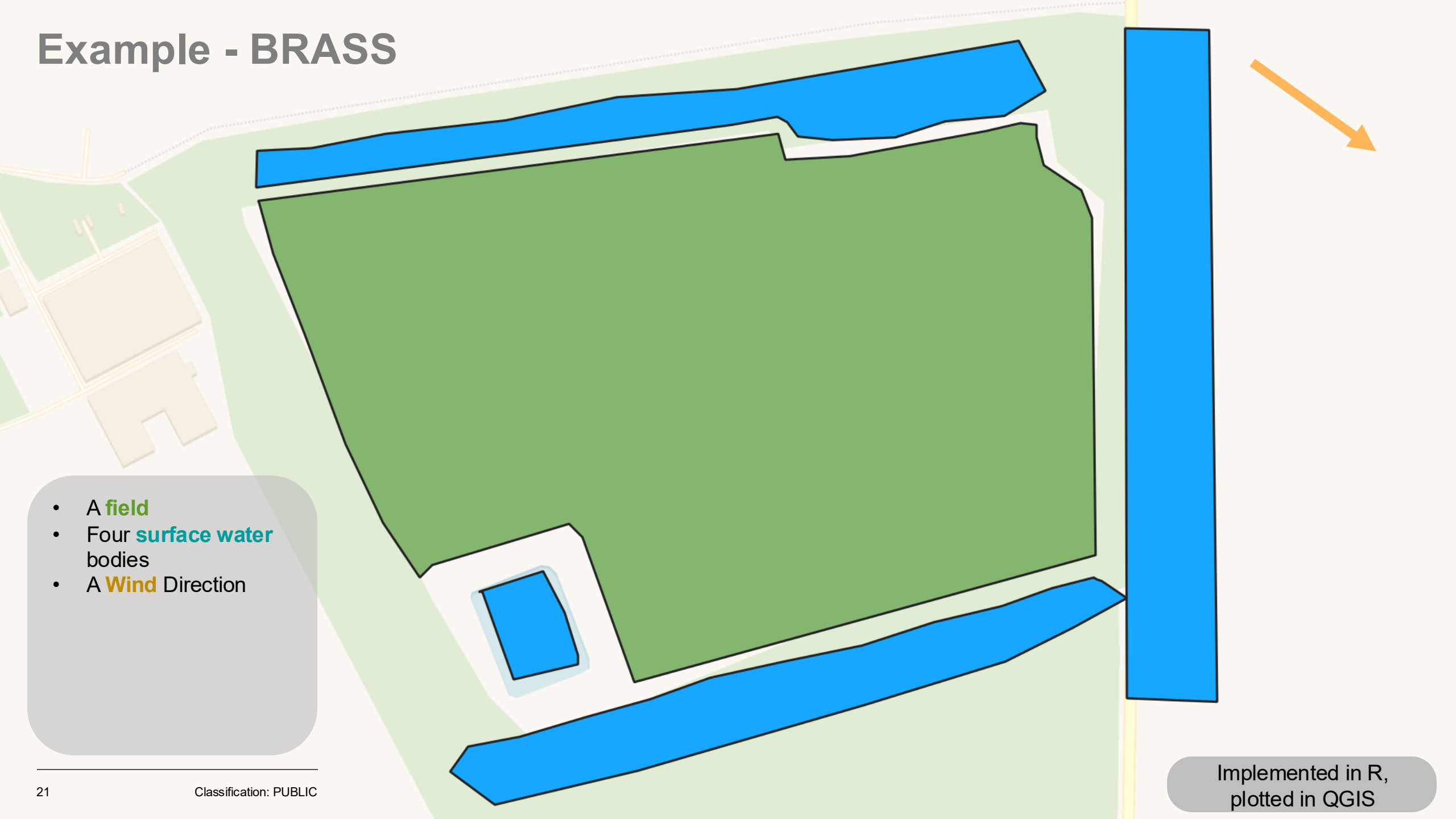
Method - BRASS

- Set Spray Intensity to 0% for close pixels until acceptable exposure



Spray Intensity measures from 0% (Light Green) to 100% (Dark Green) of Full Field rate

Example - BRASS

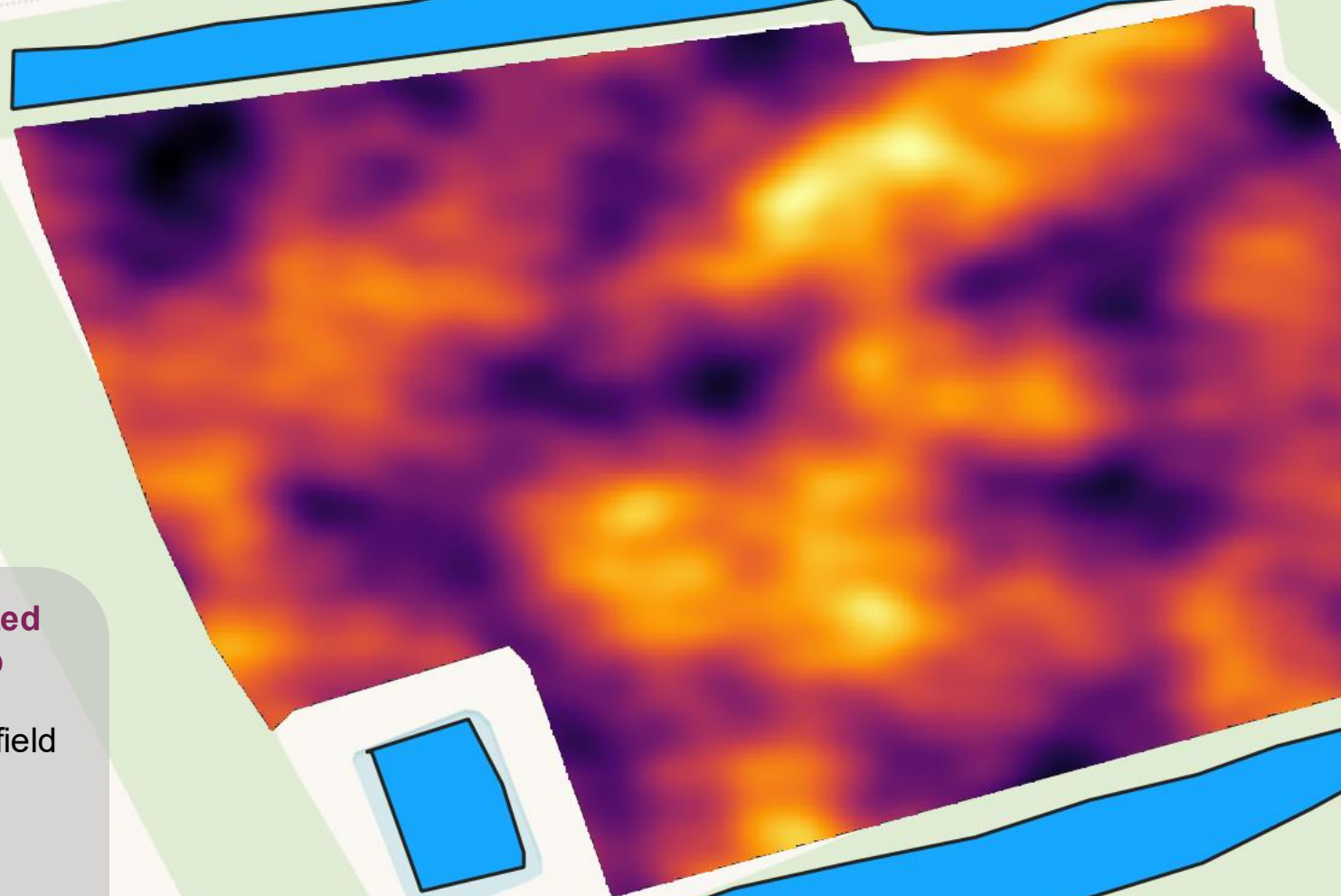


Example - BRASS

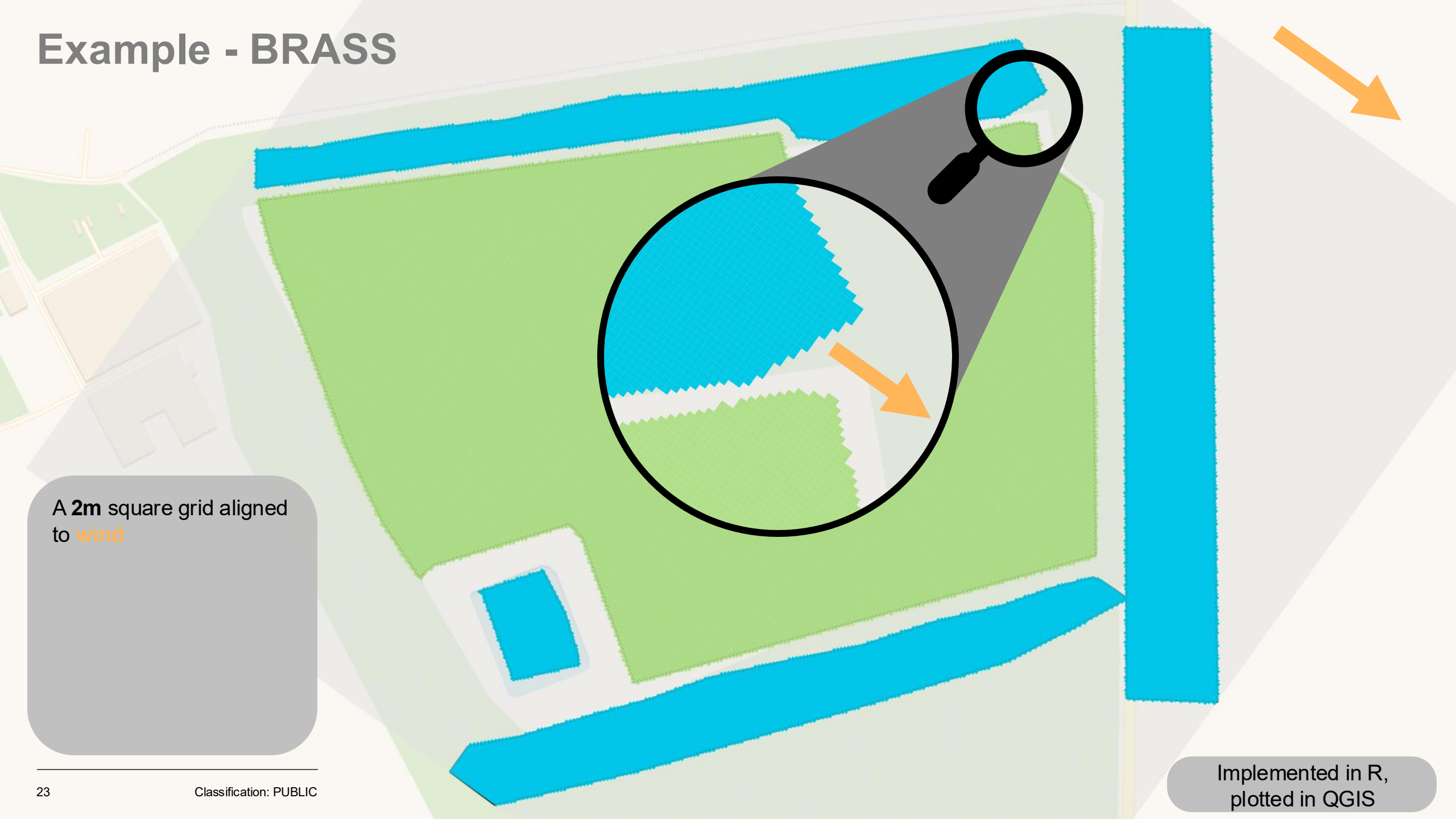
A randomly generated
spray intensity map

with

- **Black** = 0% of full field
- **Yellow** = 100%

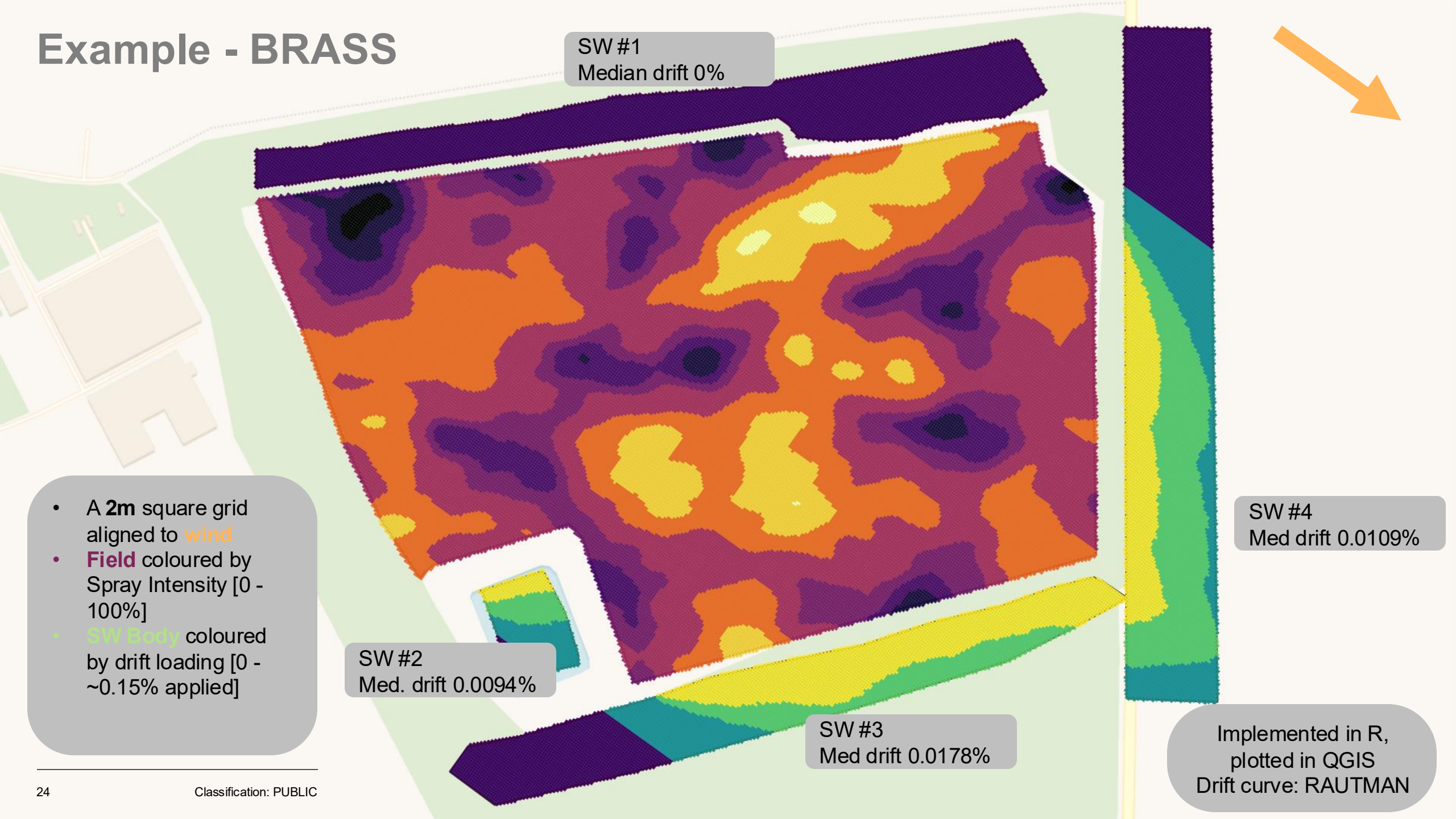


Example - BRASS



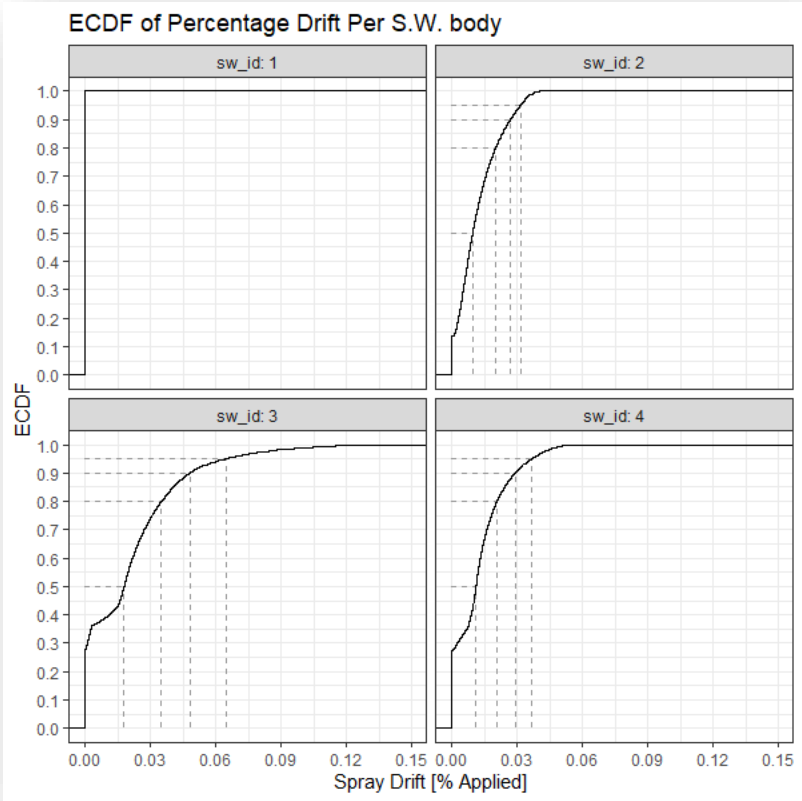
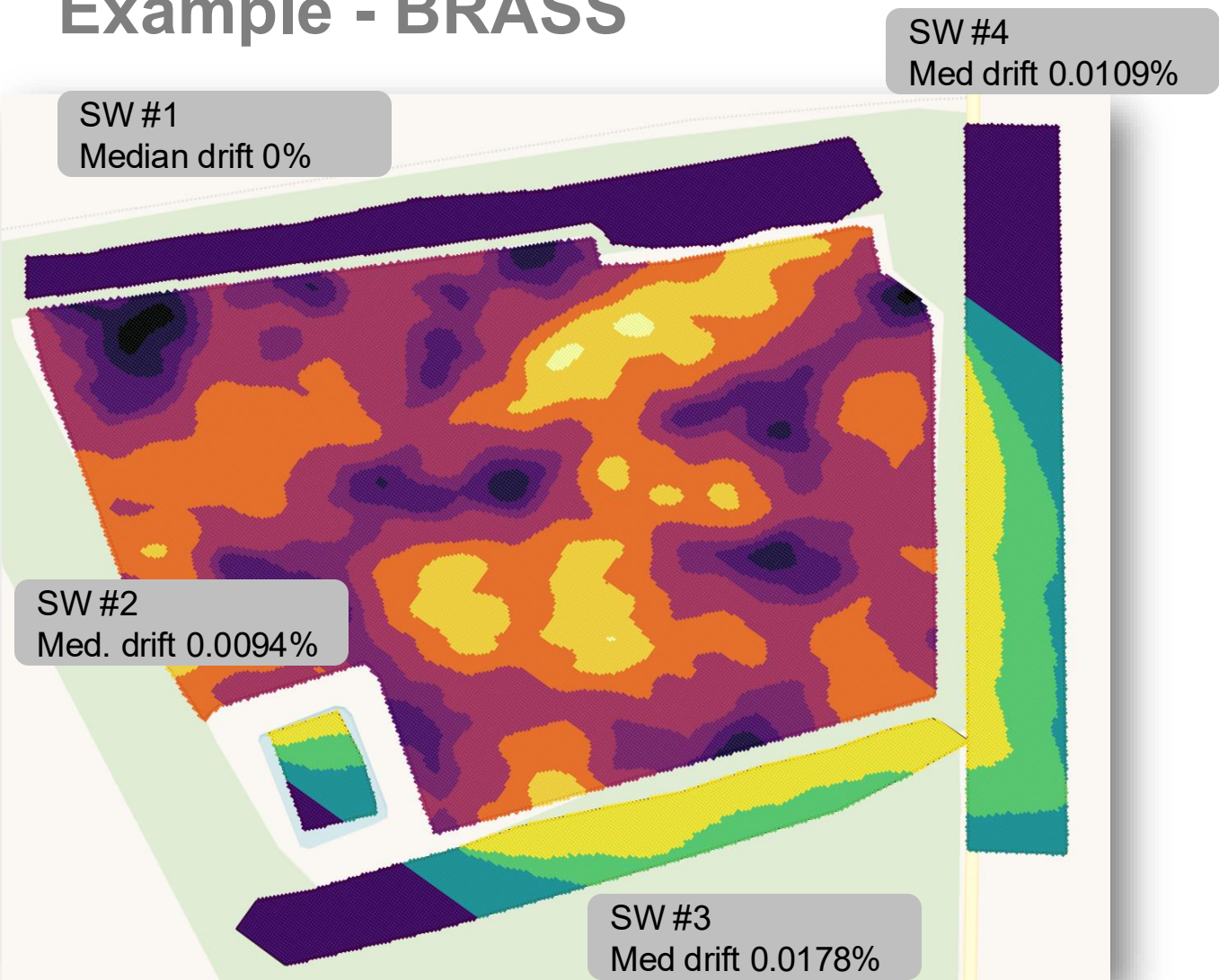
A **2m** square grid aligned to **wind**

Example - BRASS



- A **2m** square grid aligned to **wind**
- **Field** coloured by Spray Intensity [0 - 100%]
- **SW Body** coloured by drift loading [0 - ~0.15% applied]

Example - BRASS

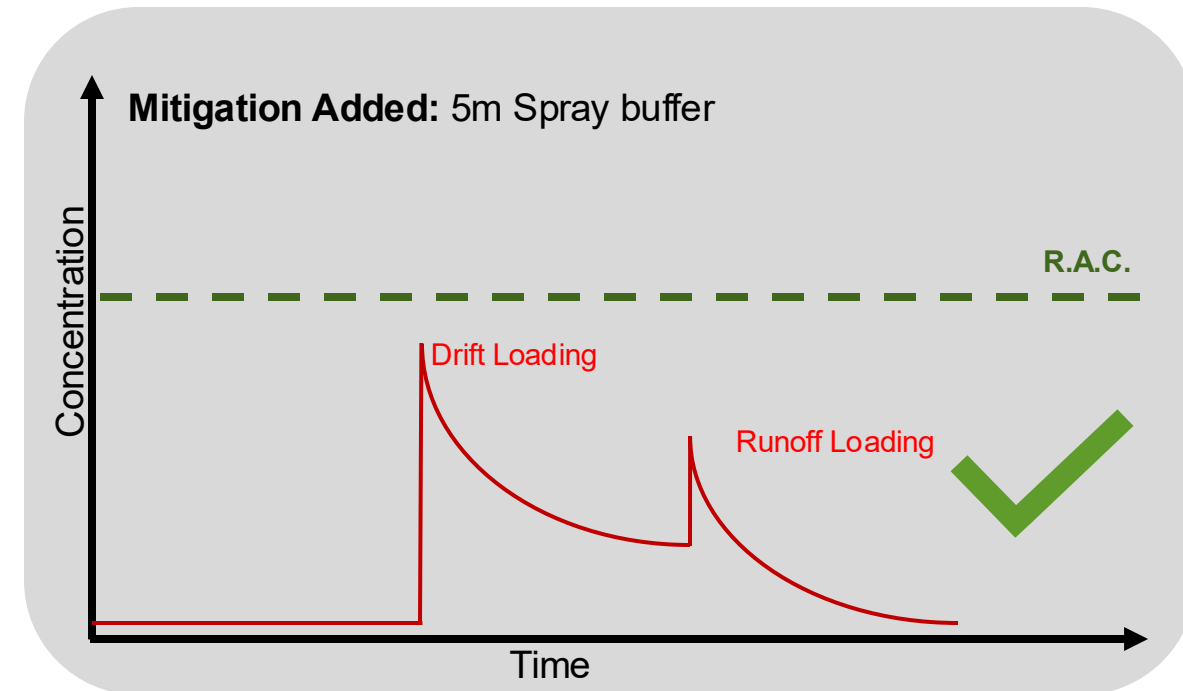
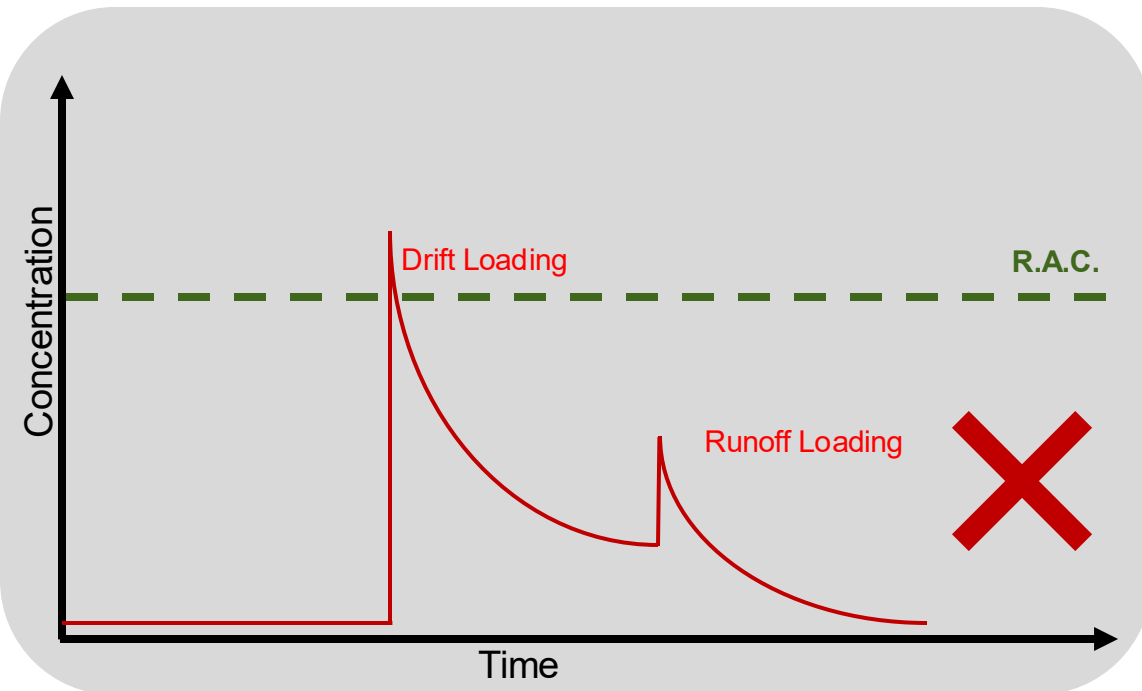


S.W. #	Spray Drift Percentage Per Pixel [% Applied Rate]				
	Mean	Percentile			
		50th	80th	90th	95th
1	0.000	0.000	0.000	0.000	0.000
2	0.012	0.009	0.020	0.027	0.031
3	0.021	0.018	0.035	0.048	0.065
4	0.012	0.011	0.021	0.029	0.037

Mean Drift deposition used in this presentation, Median, or other percentiles of Spray Drift deposition available

Linking to Existing Risk Assessment

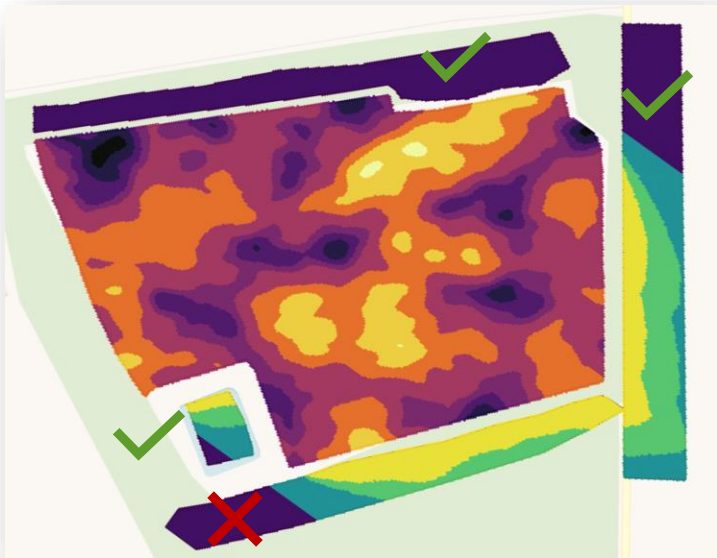
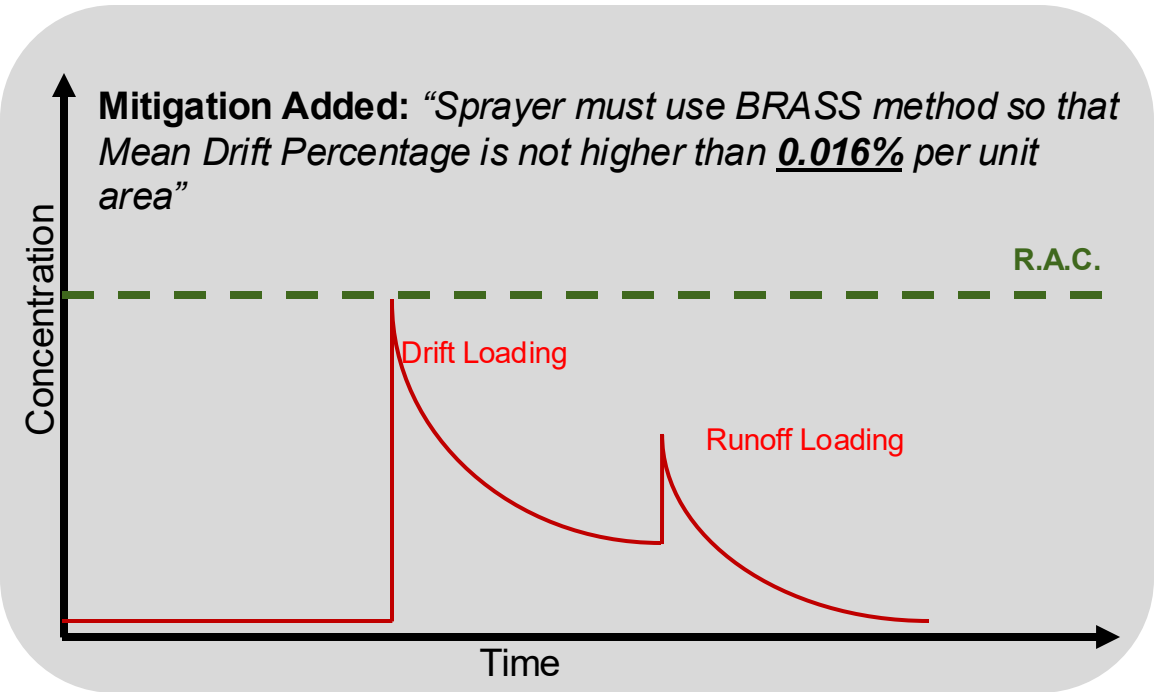
- Current FOCUS SW calculates a fixed drift value (Rautmann), simulates a scenario for one year with entries of drift, and one of runoff or drainage
- If the maximum concentration is over the Regulatory Acceptable Concentration R.A.C. you need to apply predefined mitigations until $PEC_{SW} < R.A.C.$



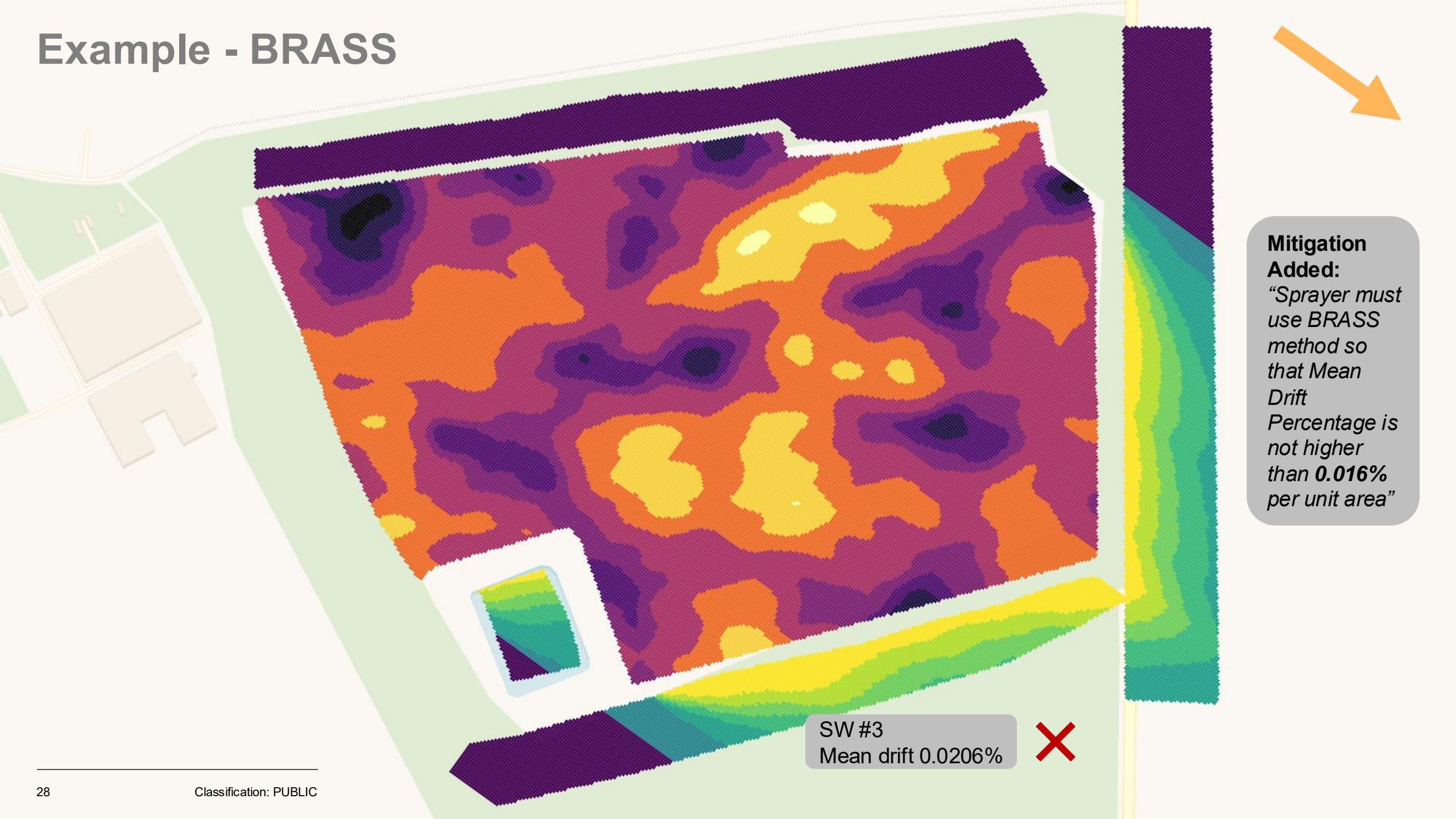
Linking to Existing Risk Assessment

- Under **BRASS**:
 - Find threshold drift percentage that leads to a pass
 - Mandate BRASS used to adjust spray map until spray drift below threshold

S.W. #	BRASS Calculated Mean Drift Deposition [%] per 2m^2	
1	0	✓
2	0.012	✓
3	0.020	✗
4	0.012	✓



Example - BRASS

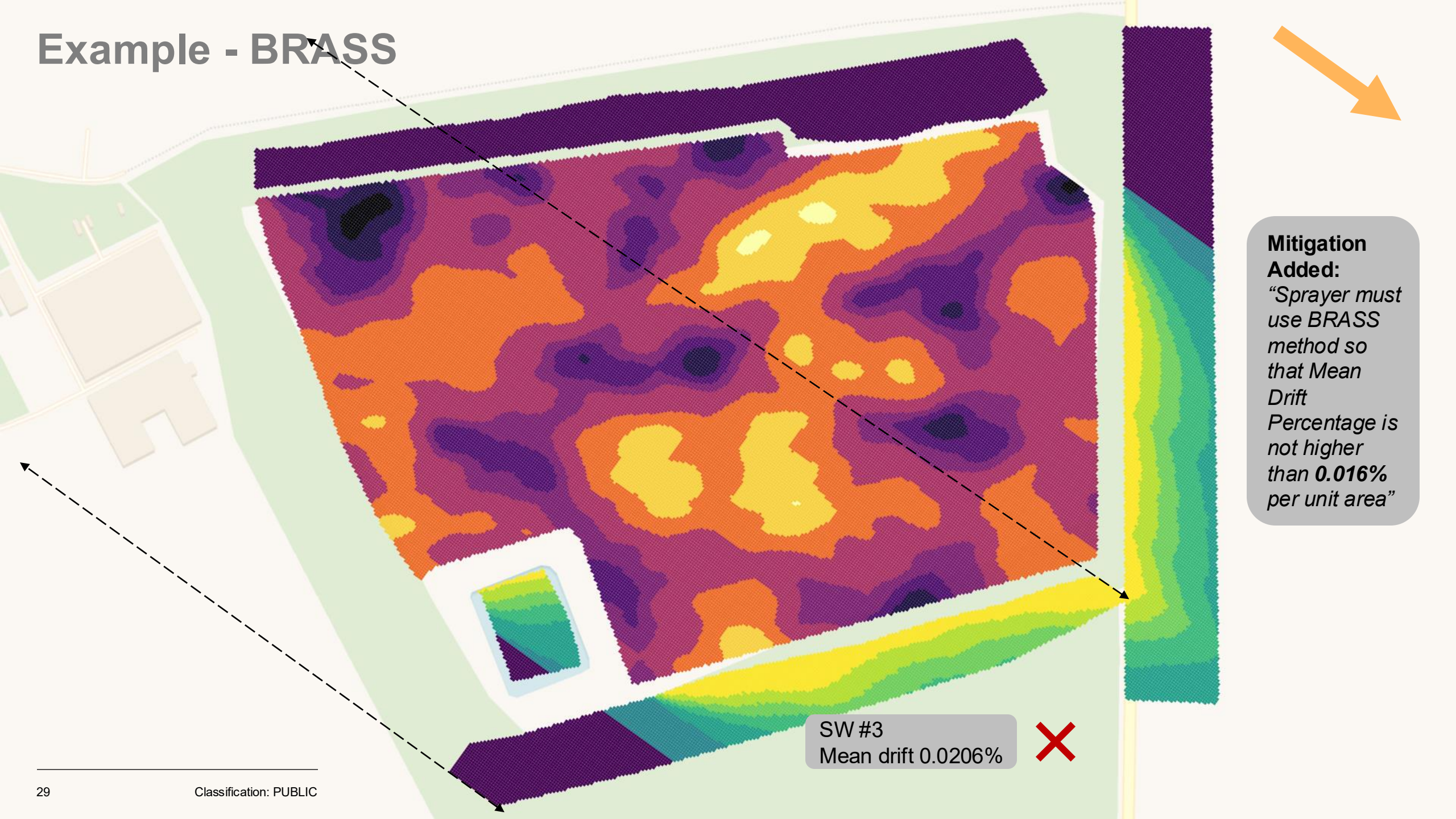


Mitigation Added:
"Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area"

SW #3
Mean drift 0.0206%



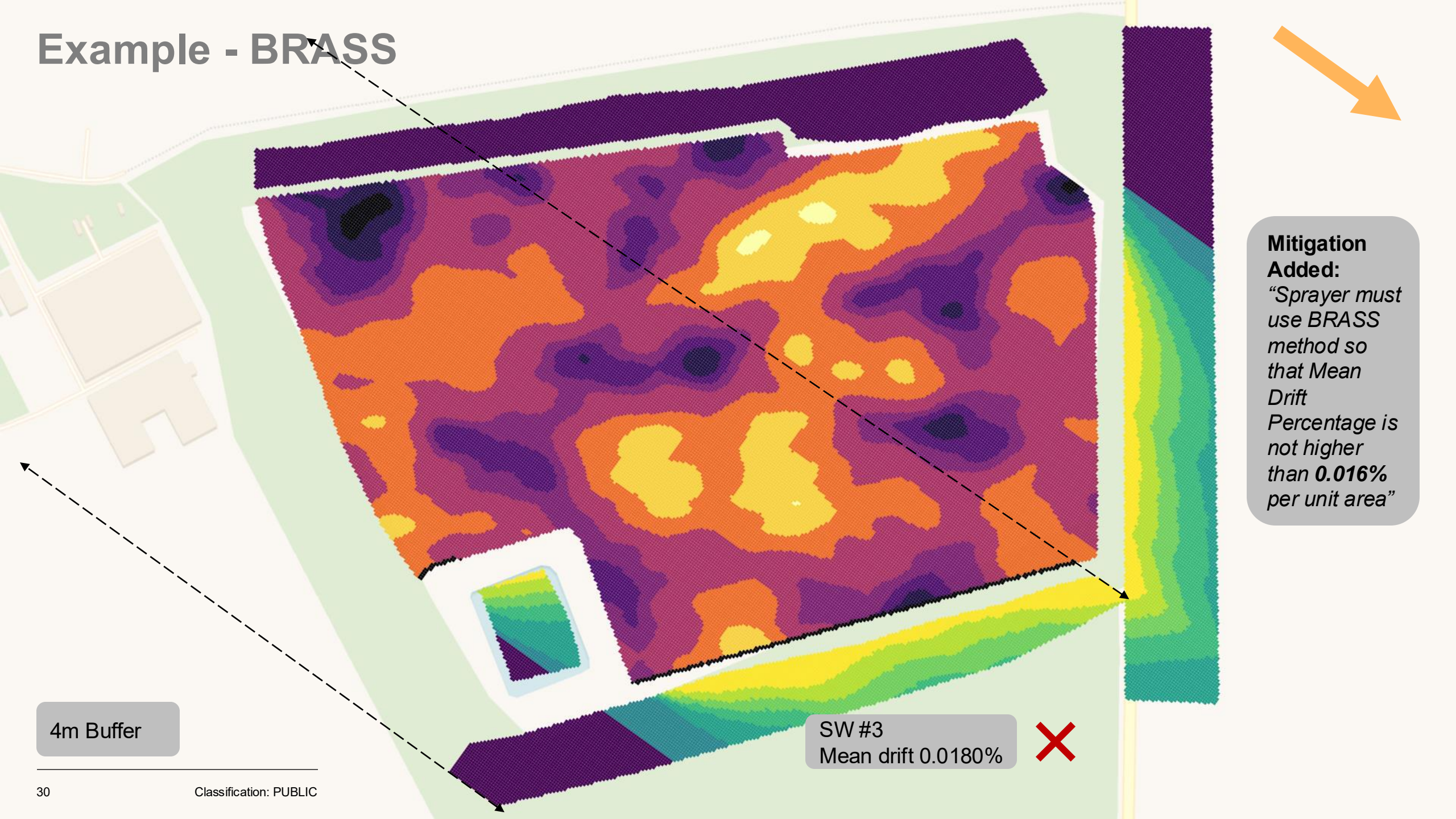
Example - BRASS



Mitigation Added:
"Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area"

SW #3
Mean drift 0.0206% **X**

Example - BRASS



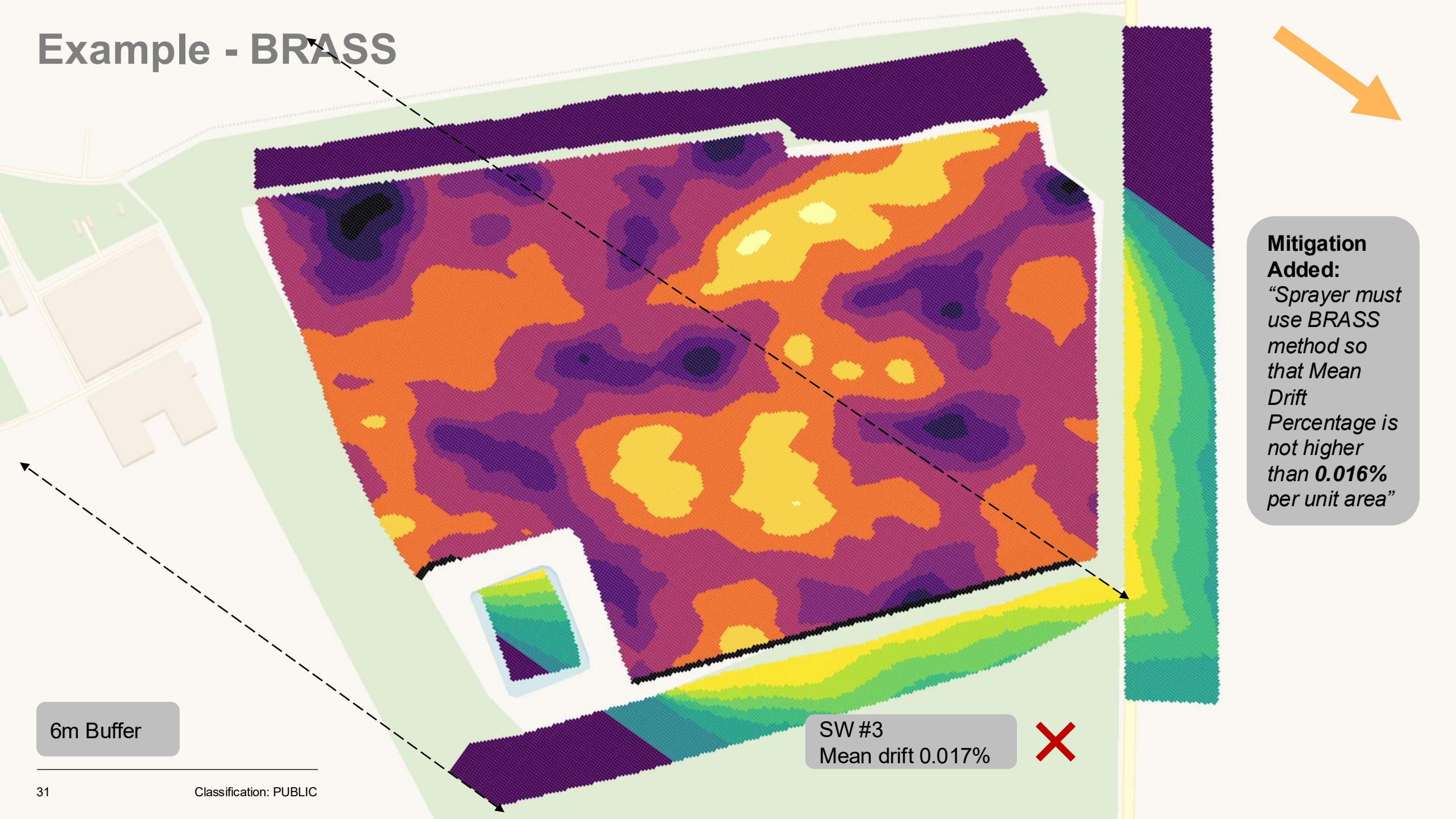
Mitigation Added:
"Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area"

4m Buffer

SW #3
Mean drift 0.0180%



Example - BRASS



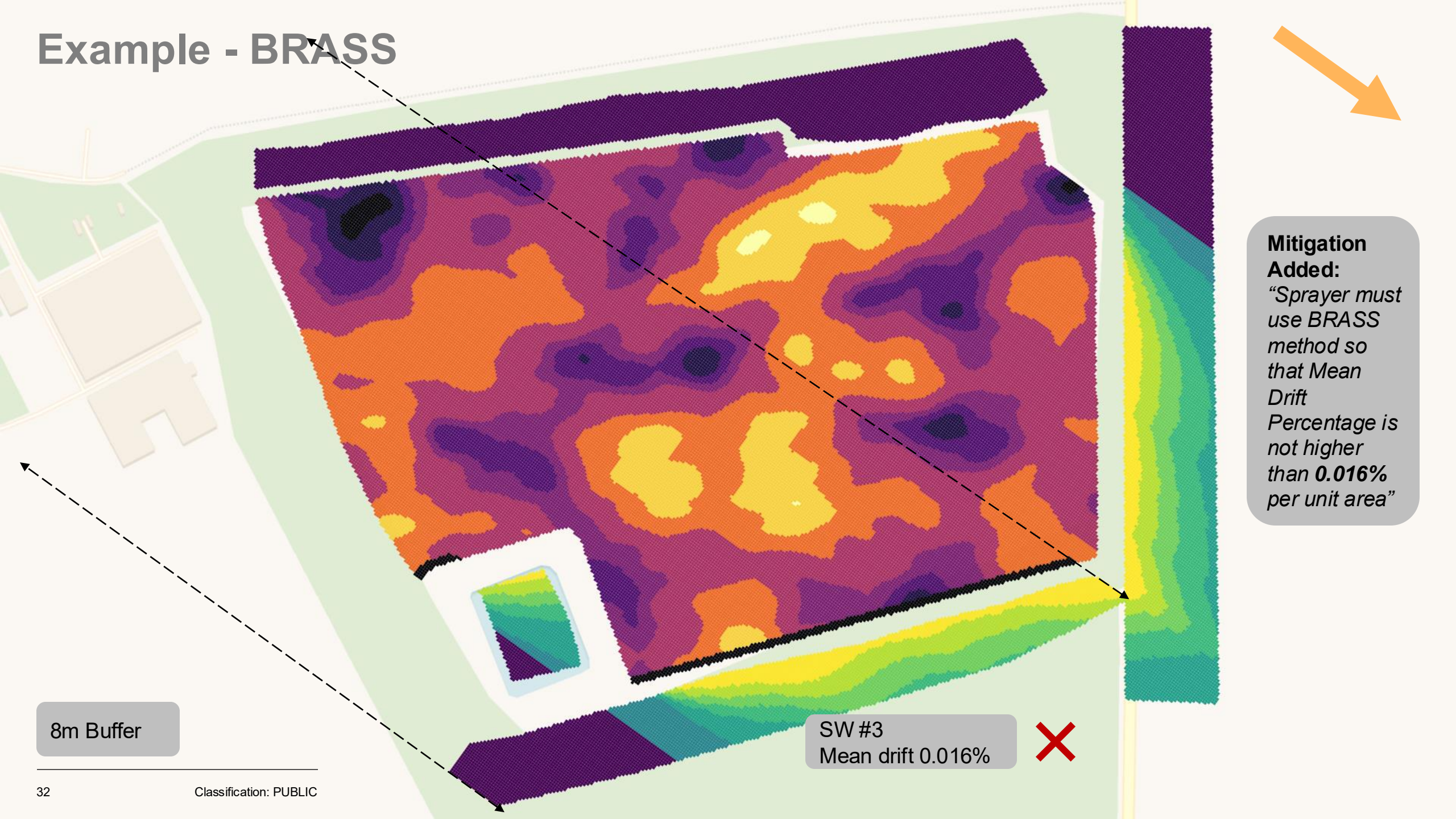
6m Buffer

SW #3
Mean drift 0.017%



Mitigation Added:
“Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area”

Example - BRASS



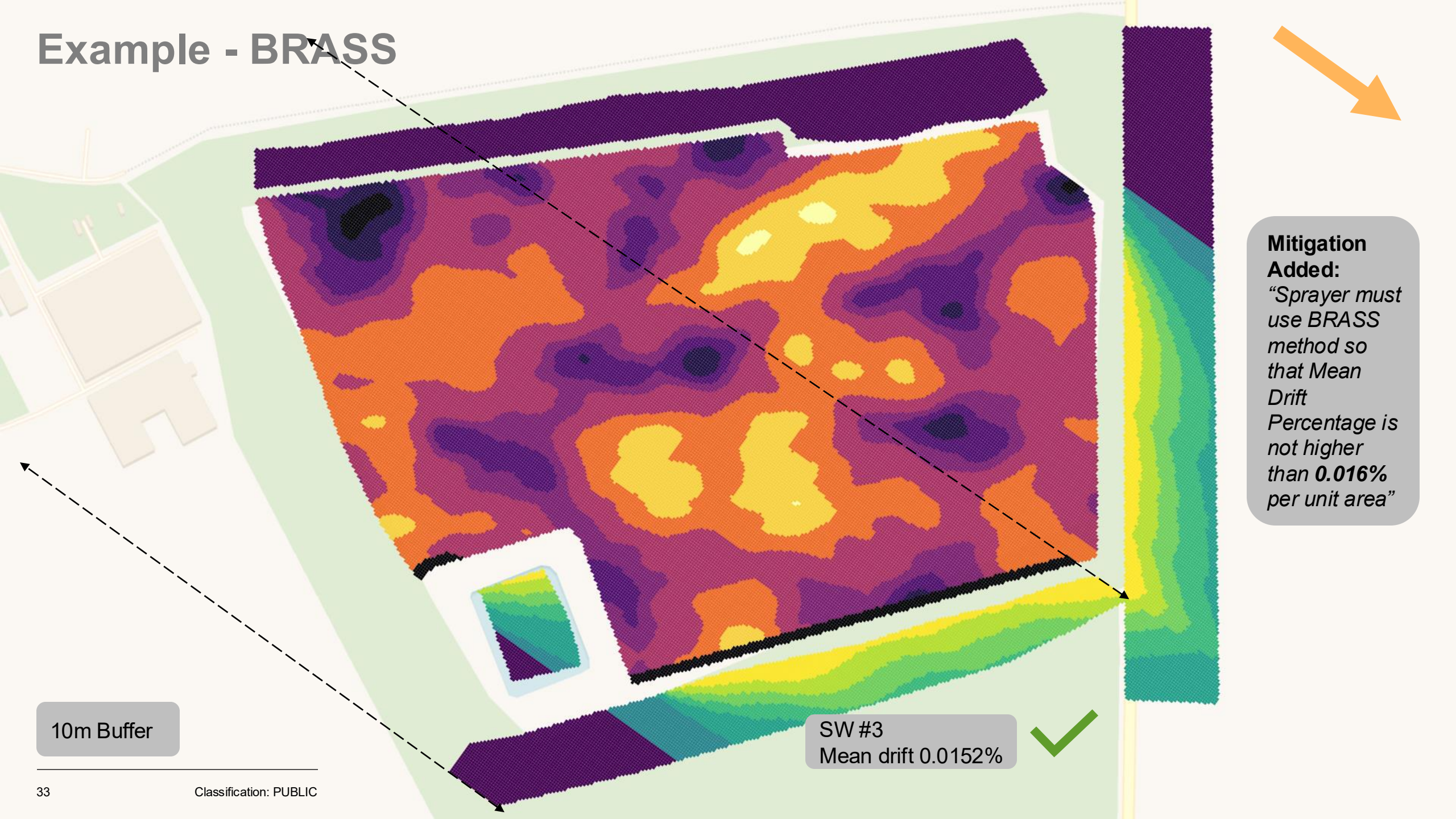
Mitigation Added:
"Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area"

8m Buffer

SW #3
Mean drift 0.016%



Example - BRASS



Mitigation Added:
"Sprayer must use BRASS method so that Mean Drift Percentage is not higher than **0.016%** per unit area"

10m Buffer

SW #3
Mean drift 0.0152%

Wrapping up

- Two new theoretical Risk Assessment techniques for Spray Drift estimation:
 - Simple Banded and Regular Spot
 - BRASS
- Both take any full-field spray drift curve as input
- Both risk assess an ideal technology. Can we:
 - Agree the ideal theory then
 - Compromise to current technology in a R.A.?
- Precision Application technology enables the possibility of per-field, live, risk assessment
- The Simple Banded and Regular Spot method, code, and web app are open source.
- BRASS is still in beta, watch this space for publication.

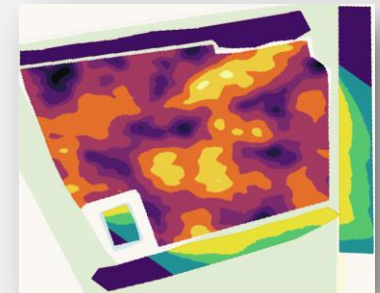
Simple Banded and Regular Spot

- Ready for the brave to try in anger for a risk assessment
- Needs crop geometry data
- Open-Source methodology →

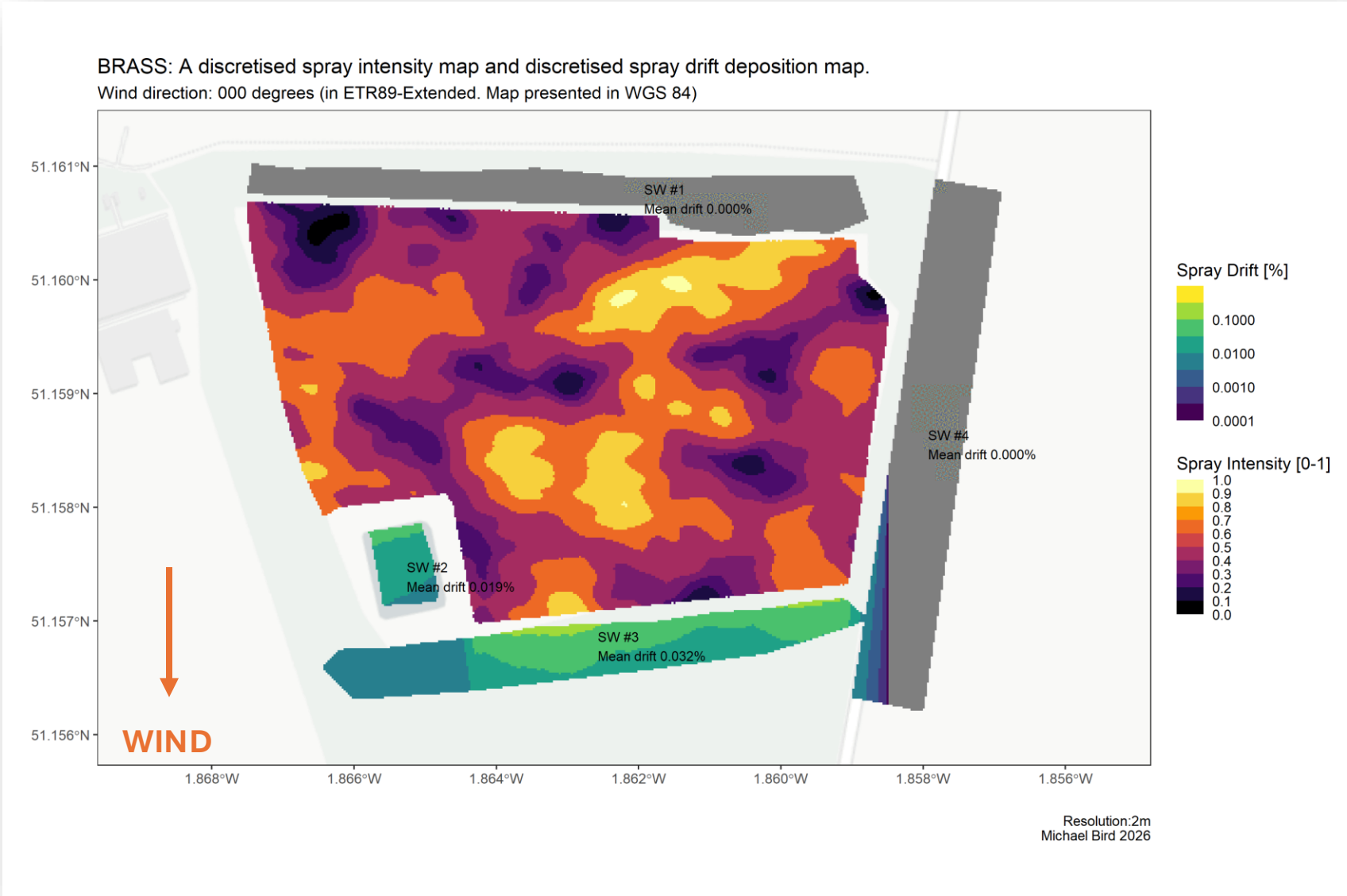


BRASS

- In-Progress methodology
- Potential for “live” risk assessment on a field-by-field basis
- Strong integration with spraying technology required



Thanks for listening



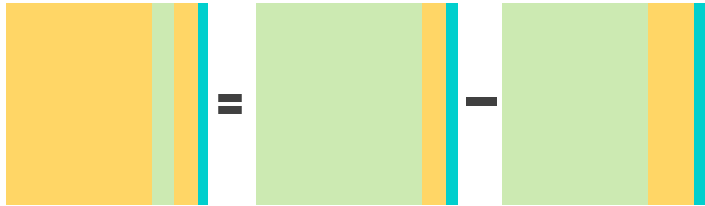


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in every field™

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BRASS - Validations

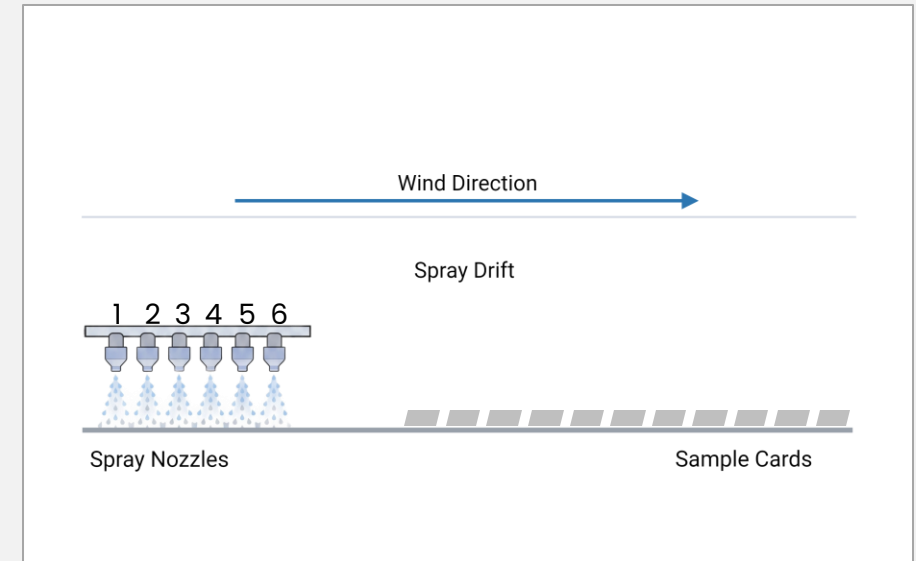
- BRASS takes as input a function of distance to predict % spray drift
- Validation is most important for the Simple Banded work as BRASS follows through from these basics.
- Investigation to confirm:



is the priority.

- A sketch of a wind tunnel validation study is in the works.
 - Run many configuration of nozzles with non overlapping spray cones
 - Fit many curves
 - Compare curves according to principle in the simple banded examples

BRASS Validation Experiment



A potential wind tunnel experiment where nozzles 1 through 6 are turned on/off in various combinations. EG, does:

- Nozzle 6 = Nozzles 123456 - Nozzles 12345 ?
- Nozzles 246 = (12-1) + (1234-123) + (123456-12345) ?



Traditional, discrete, sample cards could be replaced by the "[Swath Gobbler's](#)" continuous receipt paper for easy sampling