

# Welcome to the Jungle... of digital image handling platforms and data properties

A general overview  
with room for discussion  
and lots of questions

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## digital image handling platforms and data properties

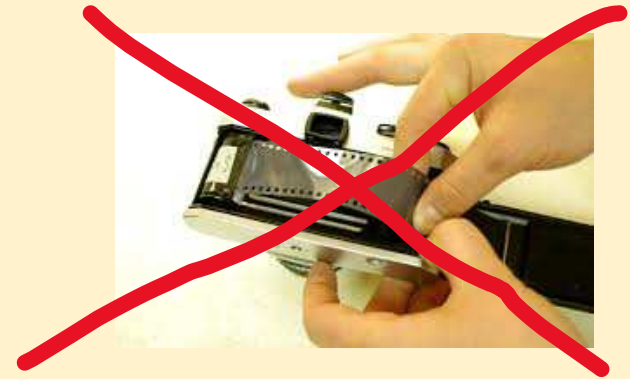
- Digital
- Image
- Handling
- Platform

- Data
- Properties

- The PlotCut 3 platform
- In its early stages
- Build with QGIS/PostGIS

Image  
handling  
platforms

# DEFINITIONS



Digital:

Stored and handled as numbers (digits) in a computer.  
Ones and zeros

Image:

A representation of “something”  
– from the real world or artificially created –  
that we can see with our eyes.

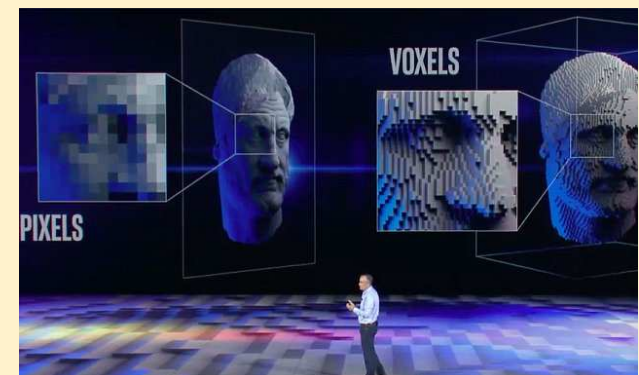
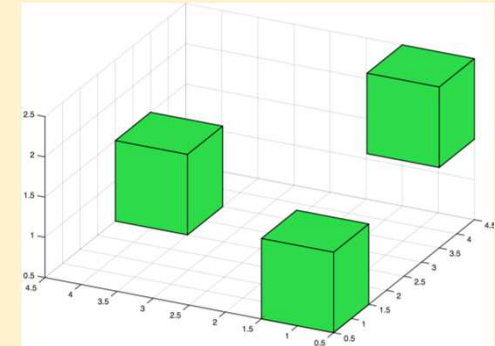
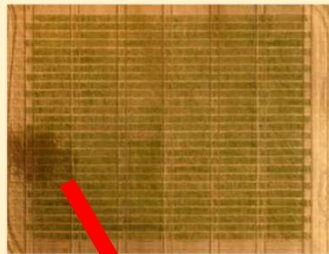
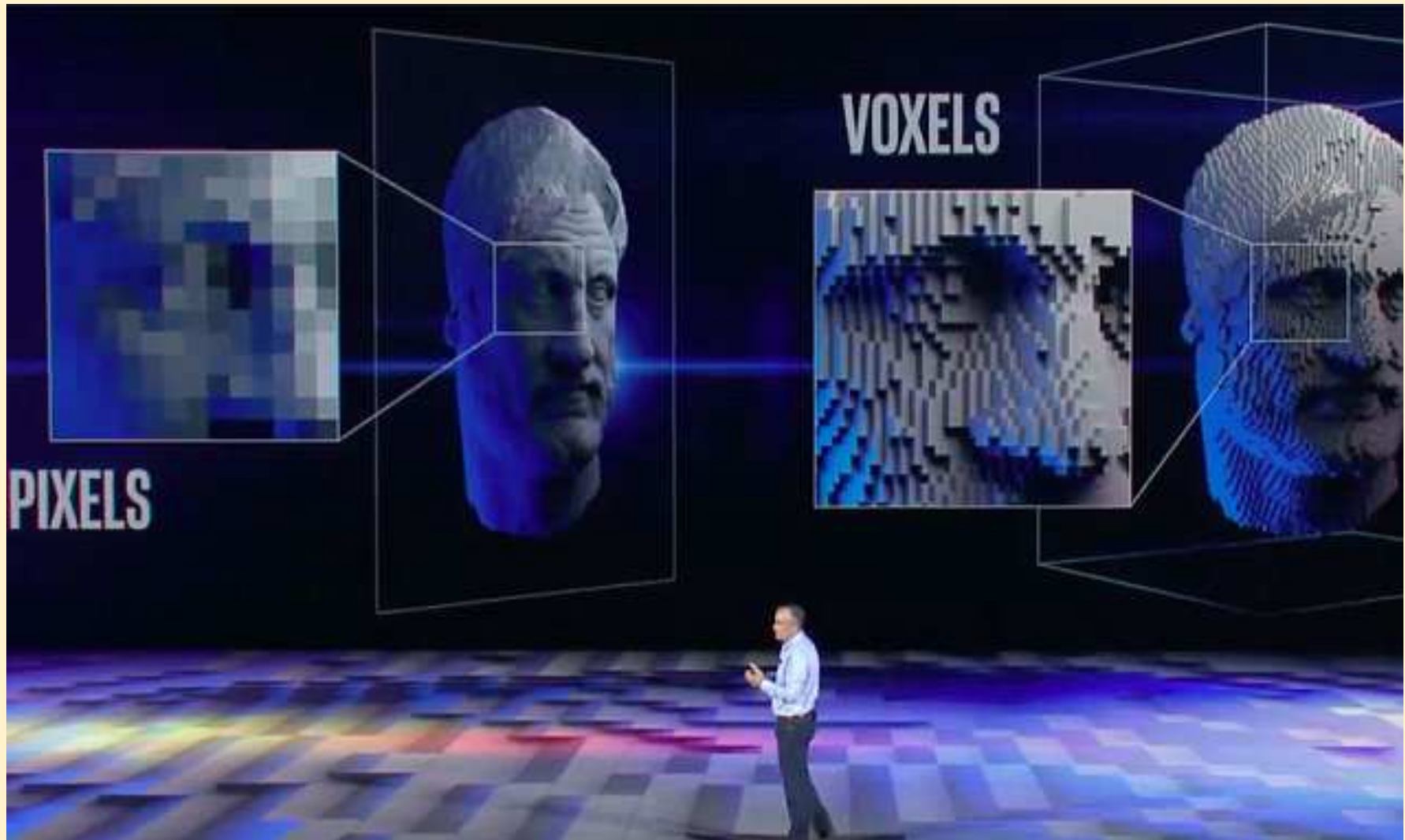


Image  
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platforms

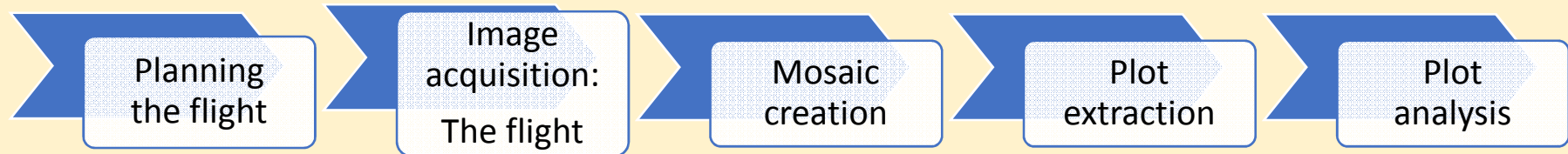


# DEFINITIONS

## Handling:

All the steps that need to be taken.

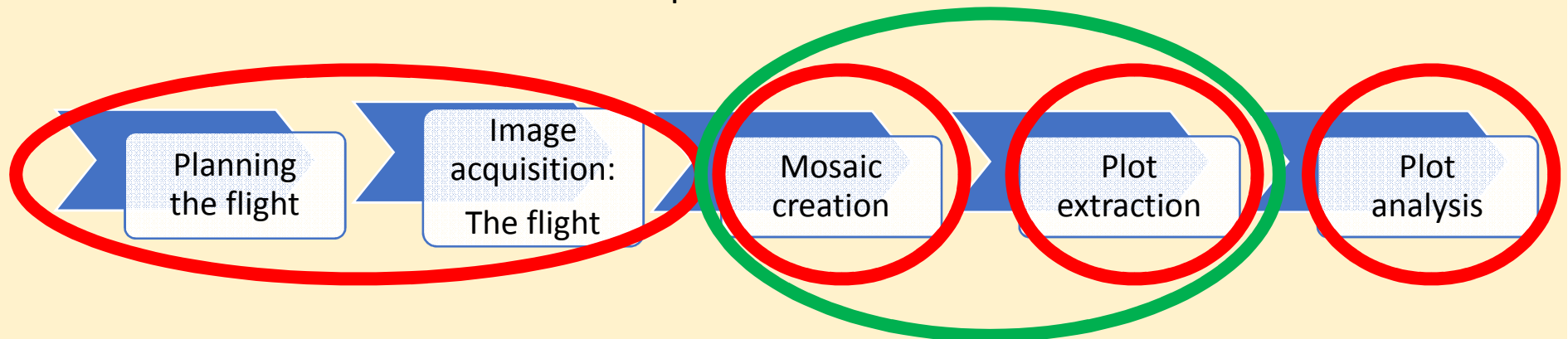
In our case, UAV imaging, a (simplified) workflow like this:



## Platform:

Where and how those steps are performed

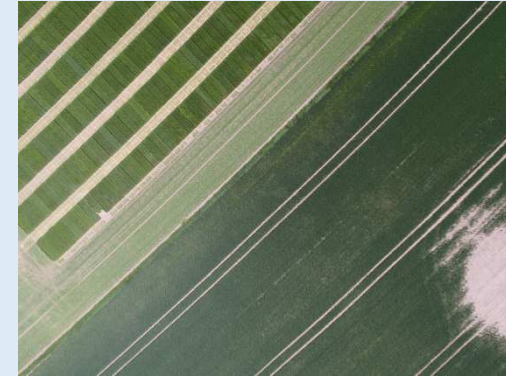
An example from our world:



# DEFINITIONS

An image, as an example:

- Data:
  - The “primary” image information itself, i.e. the pixels
  - And, the information about the recording of the image. The META data. The image properties
- Properties
  - Examples of an image’s properties
  - Represents a spatial location



D:\_0558.JPG (Metadata)	
Non-editable Properties	
Color space:	RGB
Dimensions:	4608 x 3456 x 24
Document Properties	
Authors:	
Copyright:	
Description:	DCIM\101MEDIA\DI_0558.JPG
Instructions:	
Subject:	
Picture Properties	
Title:	
Aperture:	F/ 1.79
Camera make:	DJI
Camera model:	FC550
Contrast:	Normal
Creation software:	v01.28.5379
Date digitized:	14:28:19 23-05-2018 <a href="#">Select operation...</a>
Date taken:	14:28:19 23-05-2018 <a href="#">Select operation...</a>
Digital Zoom:	Off
Exposure bias:	0 stops
Exposure program:	Manual
Exposure time:	1/3205 seconds
F-number:	F/ 1.80
Flash:	No flash function
Focal length:	15 mm
Focal length (35mm):	30 mm
GPS Altitude:	5.96 metres
GPS Latitude:	55° 48' 28.483700" N
GPS Longitude:	9° 57' 46.646700" E
ISO speed:	ISO 100
Metering mode:	Center weighted average
Rotation:	0°
Saturation:	Normal
Scene capture type:	Standard
Sharpness:	Normal
Shutter speed:	1/3198 seconds
Subject distance:	Unknown
White balance:	Manual
Extended Properties	
Comment:	0.9199
Rating:	☆☆☆☆☆ X
Tags:	N-AS
Standard Properties	
Attributes:	<input checked="" type="checkbox"/> A <input type="checkbox"/> C <input type="checkbox"/> E <input type="checkbox"/> H <input type="checkbox"/> R <input type="checkbox"/> S <input type="checkbox"/> I
Date created:	00:15:04 18-11-2018 <a href="#">Select operation...</a>
Date modified:	15:28:32 23-05-2018 <a href="#">Select operation...</a>

## Data properties

# Example properties of an image

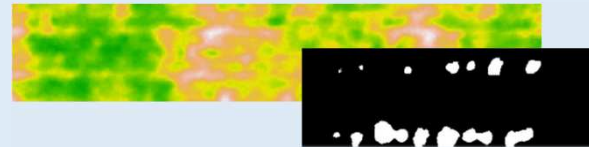
- All colors or greyscale? The quality of that color
- Size: width\*height
- What glass in front of the sensor?
- Where on our planet?
- How fast did we capture that part of our world?
- UNKNOWNNS .....

DJI_0558.JPG (Metadata)	
Non-editable Properties	
Color space:	RGB
Dimensions:	4608 x 3456 x 24
Document Properties	
Authors:	
Copyright:	
Description:	DCIM\101MEDIA\DJI_0558.JPG
Instructions:	
Subject:	
Title:	

Picture Properties	
Aperture:	F/ 1.79
Camera make:	DJI
Camera model:	FC550
Contrast:	Normal
Creation software:	v01.29.5379
Date digitized:	14:28:19 23-05-2018
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Exposure bias:	0 stops
Exposure program:	Manual
Exposure time:	1/3205 seconds
F-number:	F/ 1.80
Flash:	No flash function
Focal length:	15 mm
Focal length (35mm):	30 mm
GPS Altitude:	5.96 metres
GPS Latitude:	55 ° 48 ' 28.485700 " N
GPS Longitude:	9 ° 57 ' 46.646700 " E
ISO speed:	ISO 100
Metering mode:	Center weighted average
Rotation:	0°
Saturation:	Normal
Scene capture type:	Standard
Sharpness:	Normal
Shutter speed:	1/3198 seconds
Subject distance:	Unknown
White balance:	Manual

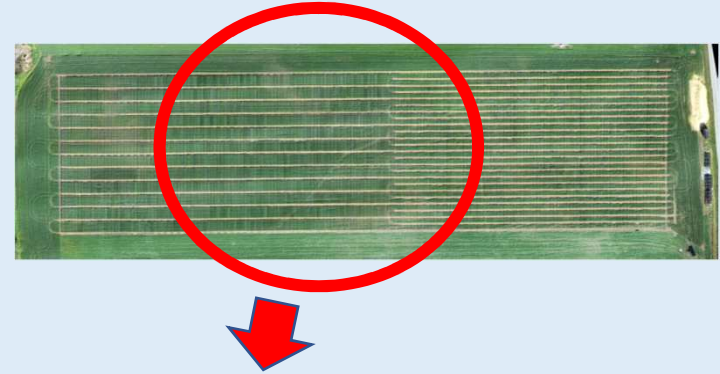
# The plot's data properties

- Static
  - Geography etc.
    - Where in the world is the plot (similar to “where was the camera”)
    - Slant of the soil surface > DEM (digital elevation model)
  - What crop is it? What variety? Maybe quality of seed sown
- Temporal
  - Climate profile: The weather that plot experienced
  - Plant morphology: The “shapes” it went through; crop height
  - Stress: Pathogens, drought etc
  - Variability within the plot
- The imaging of that single plot
  - Each image, each mosaic contains a mapping of theses static and temporal/dynamic properties
  - Image quality?
    - Resemblance to reality?
    - Mosaic vs original single image from the UAV



# The trial field's data properties

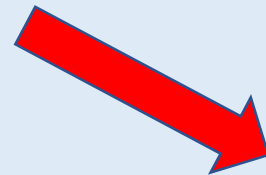
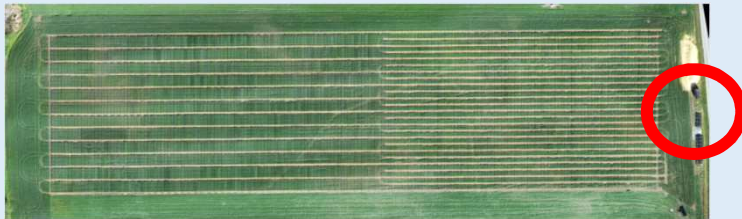
- Again, geography.  
The DEM (digital  
elevation model)
- Any damage?
- Soil map etc
  - Variation within  
the field?



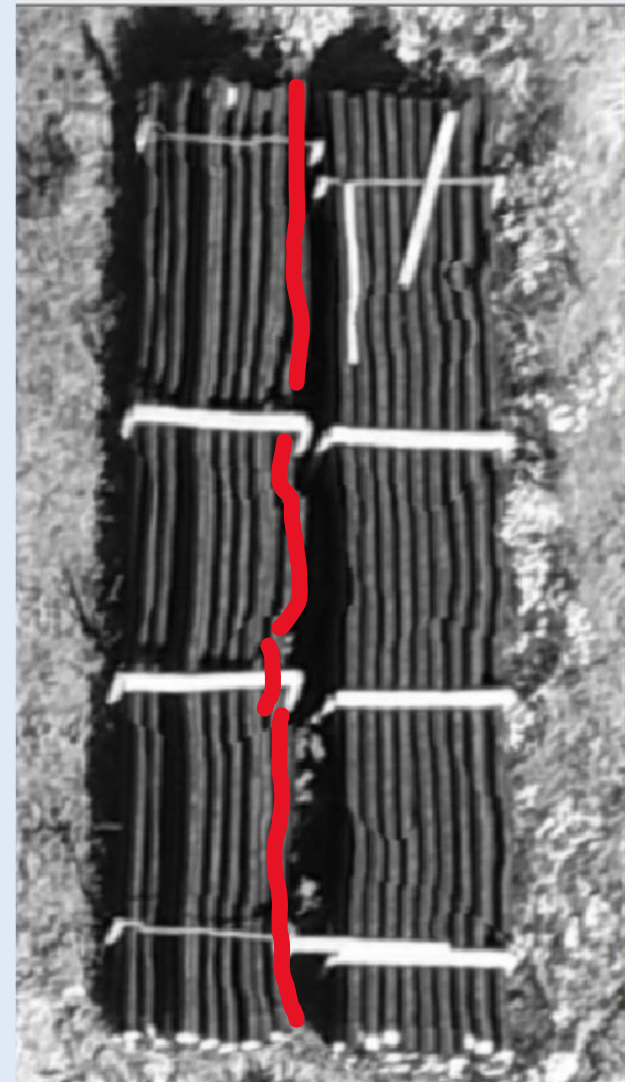
# The UAV mission's data properties

- Static
  - Geography etc.
    - Slant of the whole surface covered in the flight  
DEM (digital elevation model)
- Temporal
  - The weather during the flight
  - Did it rain earlier today? Wet soil, crop?
  - Changing cloud cover during the flight?

# The orthomosaic's data properties



- Quality of the data?
  - Structure (stitching artefacts)
  - Color (changing light, cloud cover)



# A quick recap: Our properties

We have properties of:

- Images from the drone
- The circumstances of the flight/UAV mission (campaign)
- The whole trial field
- All the individual plots
- The resulting orthomosaic
- Aaaaaaand..... Maybe a lot of “soft” data properties in the annotations. Might only be quantifiable later.
  - “It feels like” – “It might be that” – “Maybe this is the case”

# Why should you, as a breeder, care about data properties?

- All the properties you already rate and use
- The modelling
  - 2D... We extract pixel information
  - Maybe 3D (height, better head counts etc)
  - Maybe used as input/parameters for machine learning, deep learning



# Examples of platforms







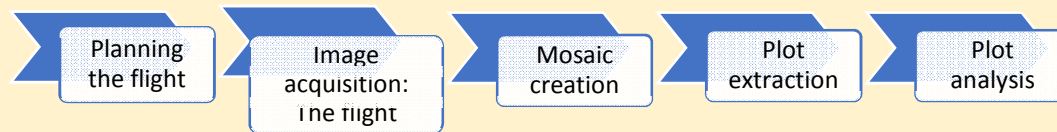






- On your own computer 
- One a computer somewhere else (server; in “The Cloud”) 
- A mix of the two    

Image  
handling  
platforms

## Example of platform mixes



- Example 1:

-  Images recorded with a drone by person A (maybe another company)
-  → Pix4D initial processing in the cloud (initiated by person A and/or B)
-   → then down to the local PC for more advanced mosaic processing in Pix4D
-  → then person B does plot info extraction in e.g. PlotCut 2
-  → maybe onwards to person C for statistics and decision support

- Example 2:





-  Images recorded with a drone by person A
-  → local complete processing of UAV images into a mosaic by person A
-  → Local data handling and plot extraction in PlotCut 2 by person A
-  → Local statistics and decision support also handled by person A

Image  
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## Another example of platform mix



### Example 3:

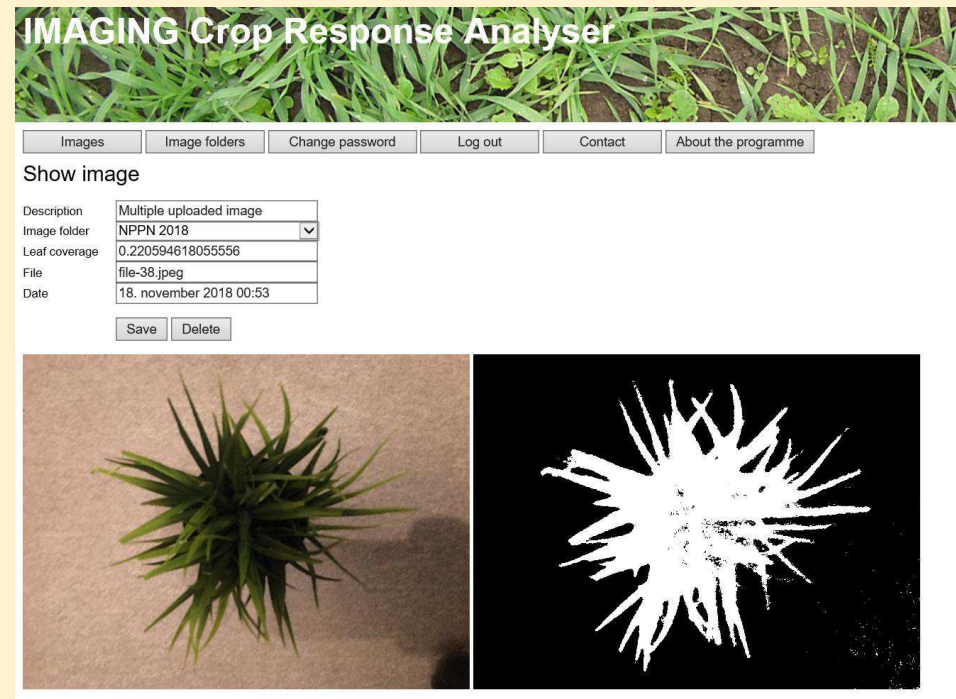
When things change with a service provider

- MicaSense: Had mosaic processing in their cloud platform (Atlas)
  - Then they changed their mind
- So now they suggest this, to get from drone images to (their) analytics:
  - ➔ Use their app, Atlas Flight for flight planning and execution 🏠
  - ➔ Process the images in Pix4D 🏠
  - ➔ Upload the images to the Atlas analysis server/cloud ☁️⬆️
  - ➔ Analyze your data in Atlas ☁️

# A simple and free approach\*

- Take plot pictures with your phone's camera
- Cut out each plot from the images
  - Maybe even on the cell phone
- Upload to a free service,
  - like the one Jesper Rasmussen has created at [www.imaging-crops.dk](http://www.imaging-crops.dk)
- There you go:
  - Fraction of image that is crop/plant
- Use the results

\* Requires only a smartphone, a pc and an Internet connection




More platforms...

# Three online approaches


- Three picked
  - DroneDeploy
  - PrecisionMapper
  - Solvi
- Their focus (currently):
  - Specific agronomy focus: Solvi
  - Wide focus: PrecisionMapper and DroneDeploy
    - Agriculture, mining, construction, forestry, roofing, solar, inspection (buildings, windmills, bridges), insurance, mapping infrastructures

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# The DroneDeploy Platform




## DroneDeploy



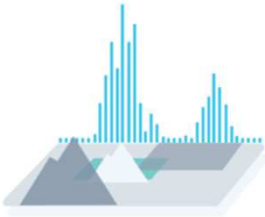
**Fly & Capture Images**

Use the DroneDeploy App for DJI Drones or your own software for other drone types.



**Map & 3D Models**

Upload your images to Map Engine to generate maps, models and more.



**Explore, Analyze & Share**

Analyze, annotate and share maps right from your device.

# The DroneDeploy Platform

- Features:
  - Volume (but not crops yet, only for mining etc)
  - View elevation data
  - Plant health assessment
  - Temporal changes: Crop development
  - Orthomosaics: Both 2D and 3D
  - Output formats: JPG, TIFF, OBJ, LAS, SHP, DXF
  - App/add-on marketplace; make your own apps
  - GCPs (costs extra)

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# The DroneDeploy Platform

## Processing: Easy

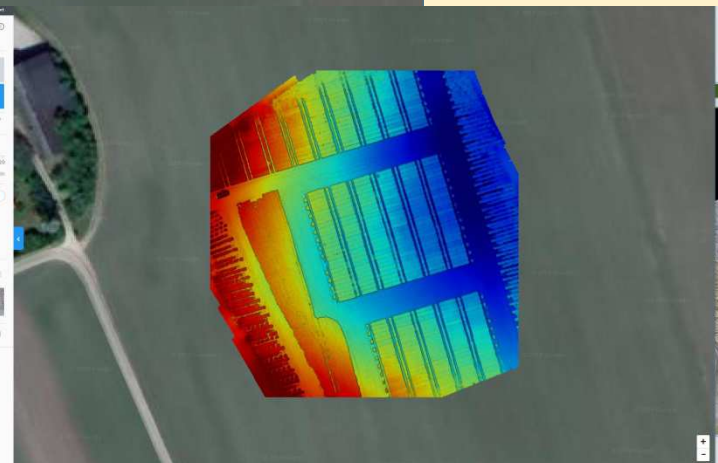
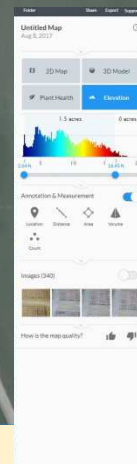
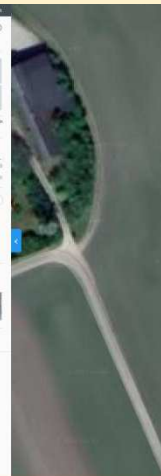
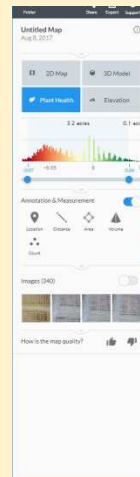
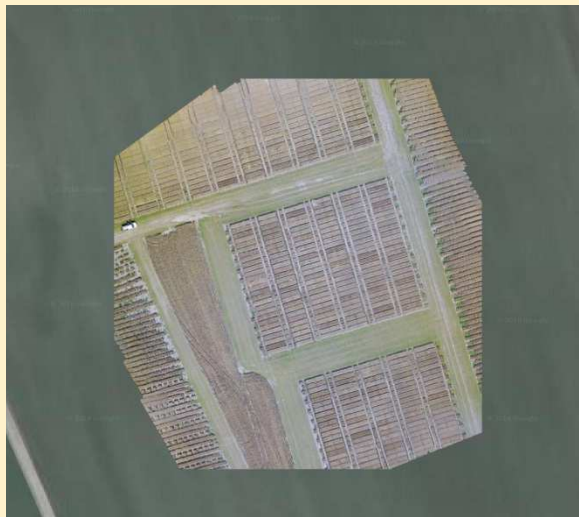
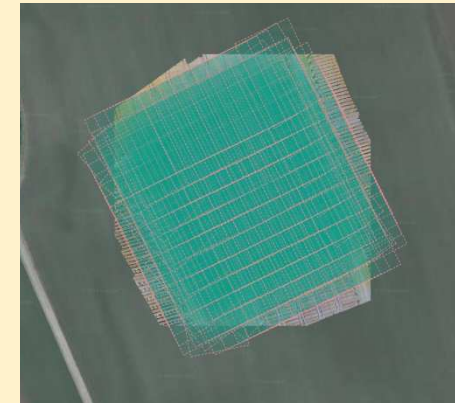
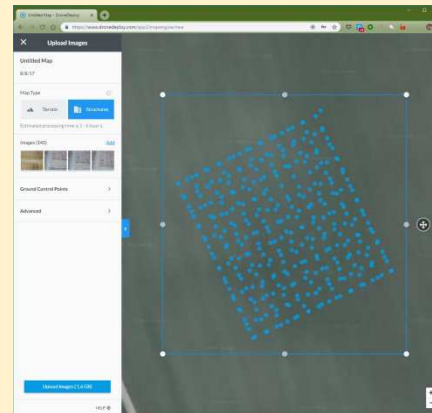
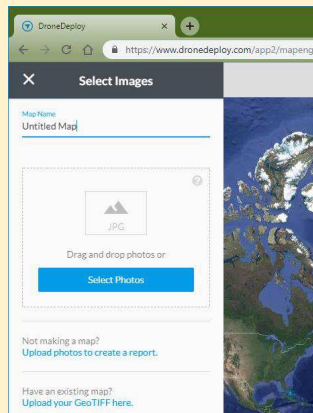


Image  
handling  
platforms

# The DroneDeploy Platform

## Marketplace example: The Side-by-side app

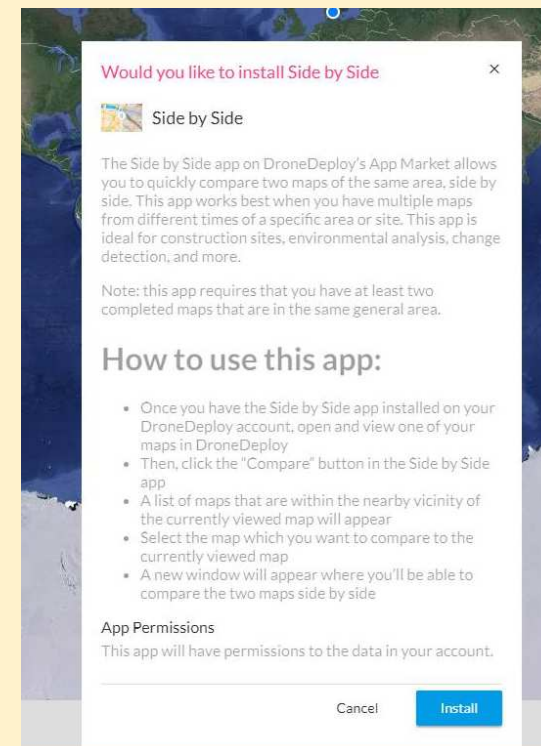
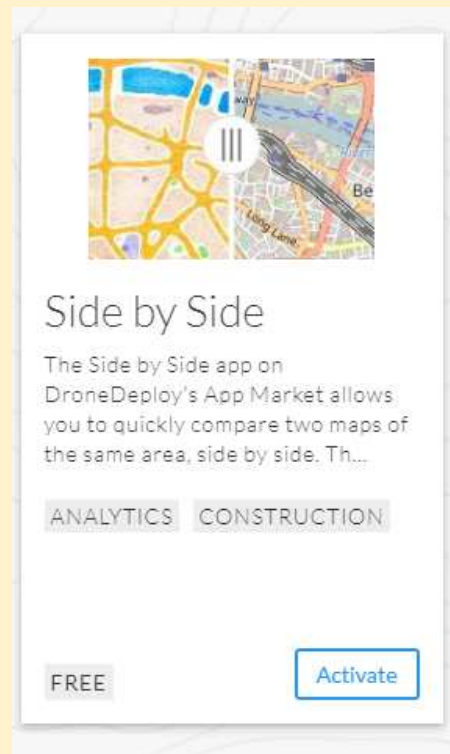
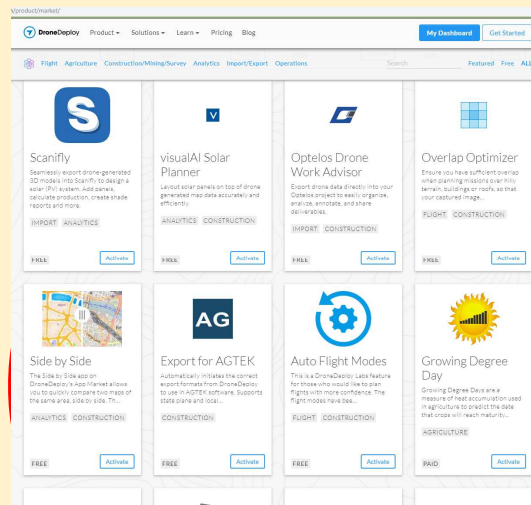


Image  
handling  
platforms

# The DroneDeploy Platform

Example: The Side-by-side app



# What is a GCP?

## Ground Control Point

- A specific measurement in the real world
  - Very precise
    - circa 1 cm precision
    - The standard drone/camera itself normally has +/- some meters precision
  - Time consuming work with ground-based gear
    - Buy or rent
- May soon be easier with better drone navigation
  - RTK drones.... You will have one in a few years

Next platform...

Image  
handling  
platforms

# The PrecisionMapper Platform



# The PrecisionMapper Platform

- Features:
  - Basic features are very much like DroneDeploy
    - Apps/add-ons differ
  - Volume (not crops yet, only mining etc)
  - View elevation data
  - Plant health assessment
  - Temporal changes: Crop development
  - Orthomosaics: Both 2D and 3D
  - Output formats: JPG, TIFF, OBJ, LAS, SHP, DXF
  - App/add-on marketplace; make your own apps
  - Use GCPs (requires desktop software install)

Image  
handling  
platforms

# The PrecisionMapper Platform

Processing: As simple as DroneDeploy

Image  
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# The PrecisionMapper Platform

## Free app: Green Leaf Index

Can be applied to:  
Standard RGB mosaic

Supported Resolution:  
20.00 cm/px or less

Estimated Processing:  
Less than 4 hours

GLI designed to adjust for  
greenness and yellowness  
in crops.

Can be used in all  
growth stages.

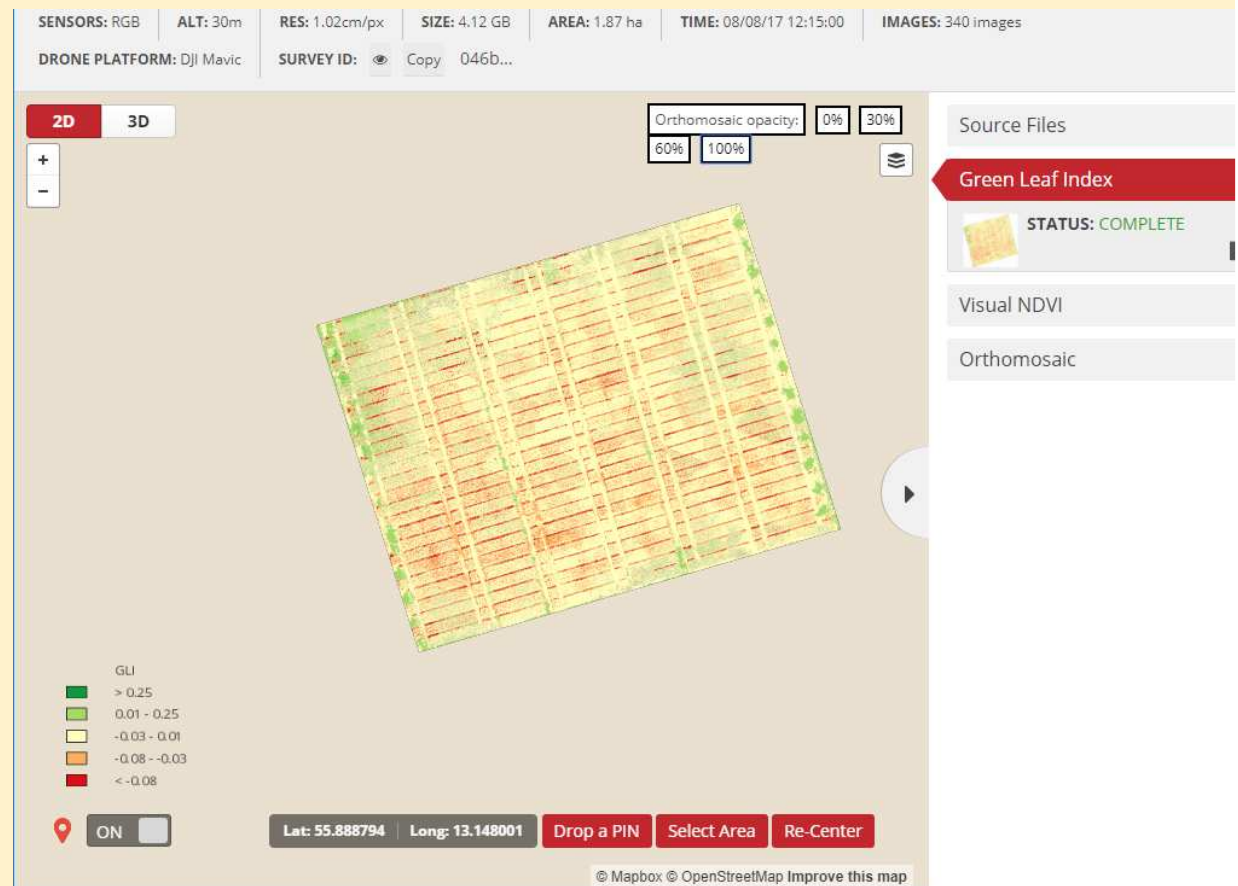


Image  
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platforms

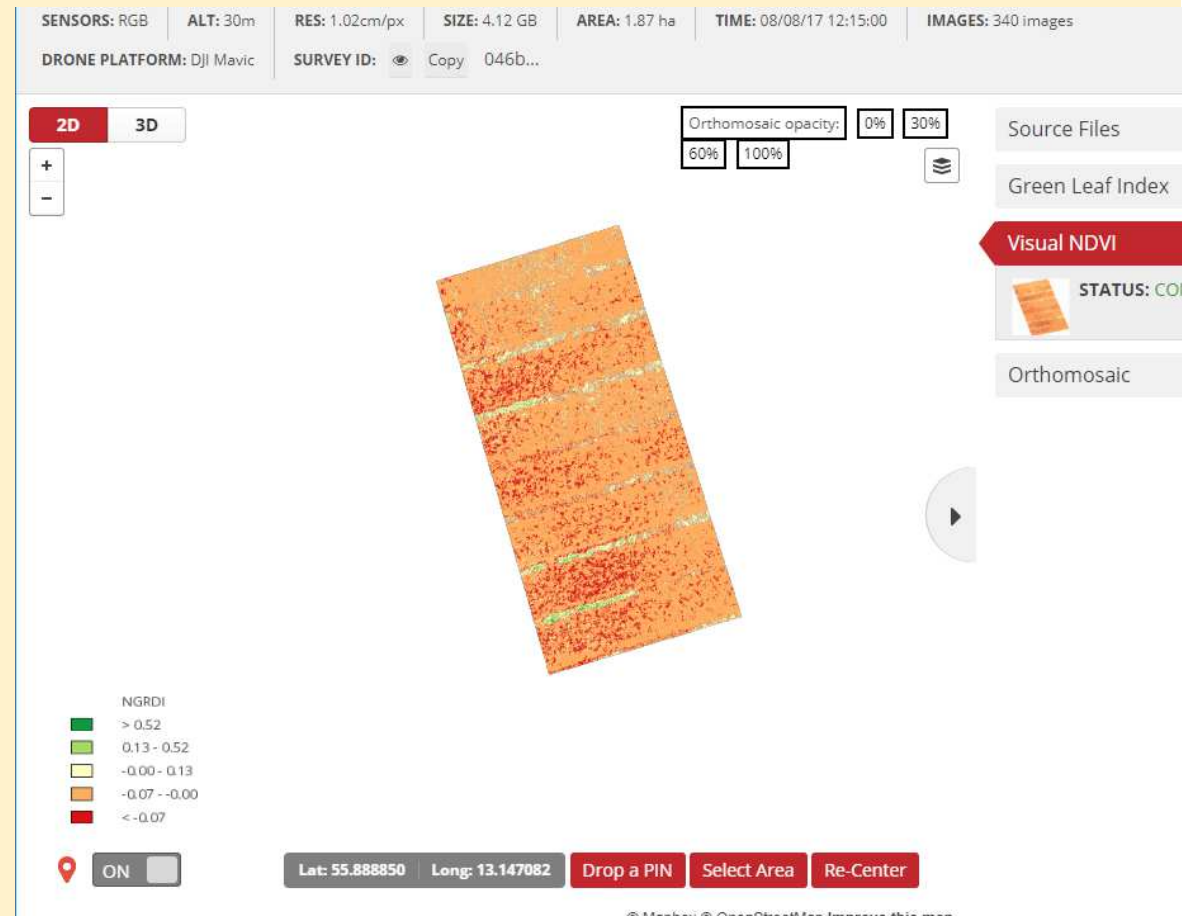
# The PrecisionMapper Platform

## Free app: Visual NDVI

Can be applied to a standard RGB mosaic

Visual NDVI, NGRDI. Indicator surface greenness, detect live green plant canopies.

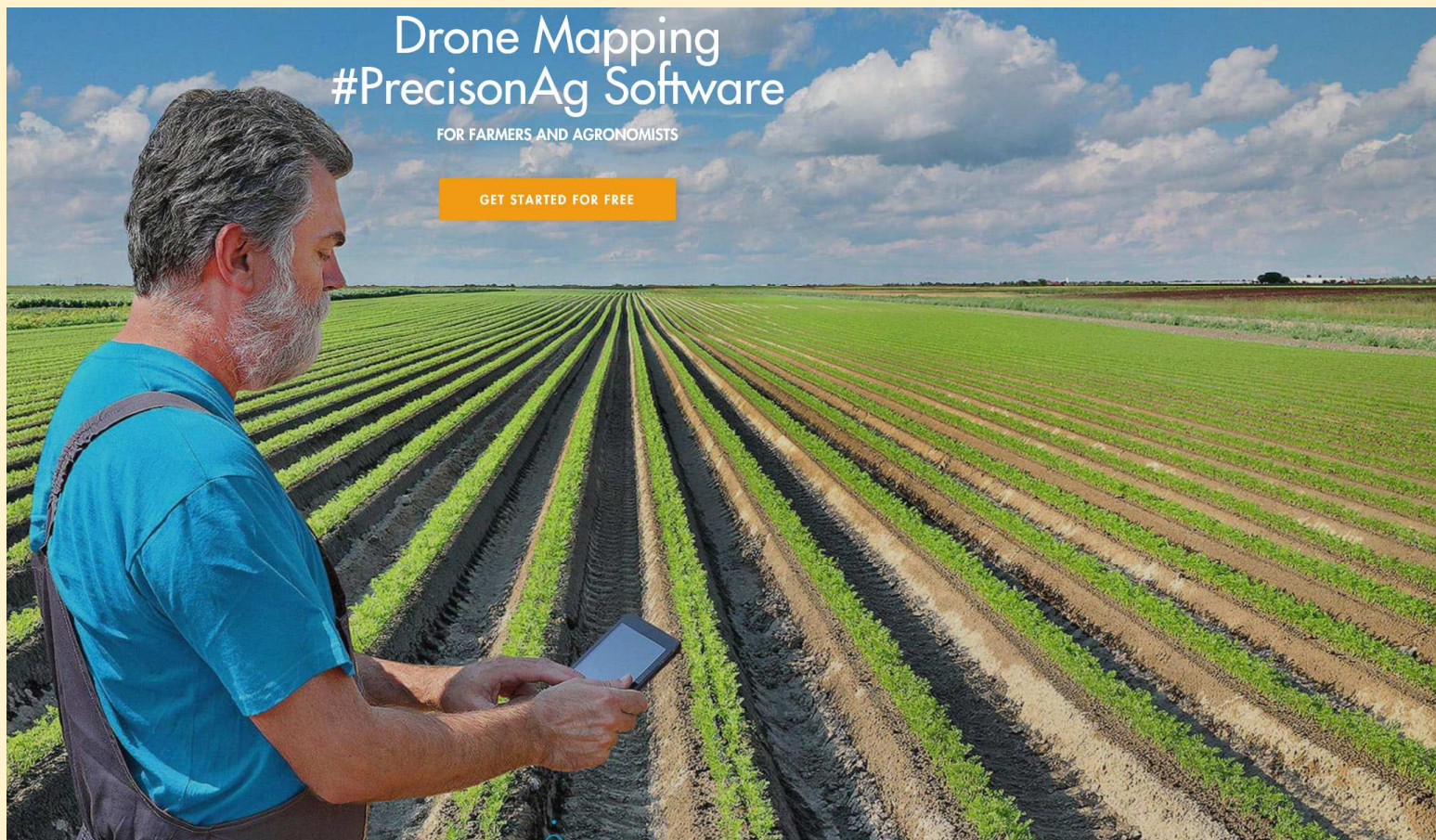
Can be used in all growth stages.



Next platform...

Image  
handling  
platforms

# The Solvi Platform



# The Solvi Platform

## Features:

- Plant Health analytics
  - Predefined or custom Vegetation indices
- Elevation maps used to correlate to crop health
- Temporal changes: Crop development
- Plant Counts
  - Whole field or custom areas
  - Asses missing plants (pattern continuity)
- No app/add-on marketplace. No creating own apps/add-ons
- Export (some of) your data
- Prescription files
- Share a web view

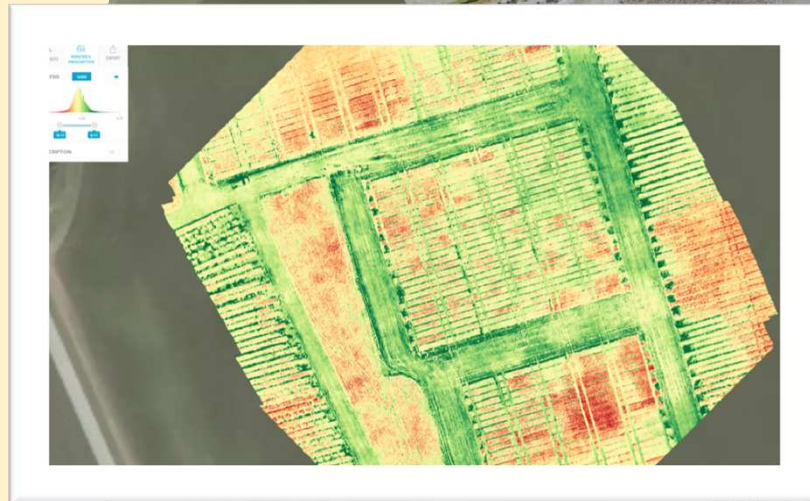
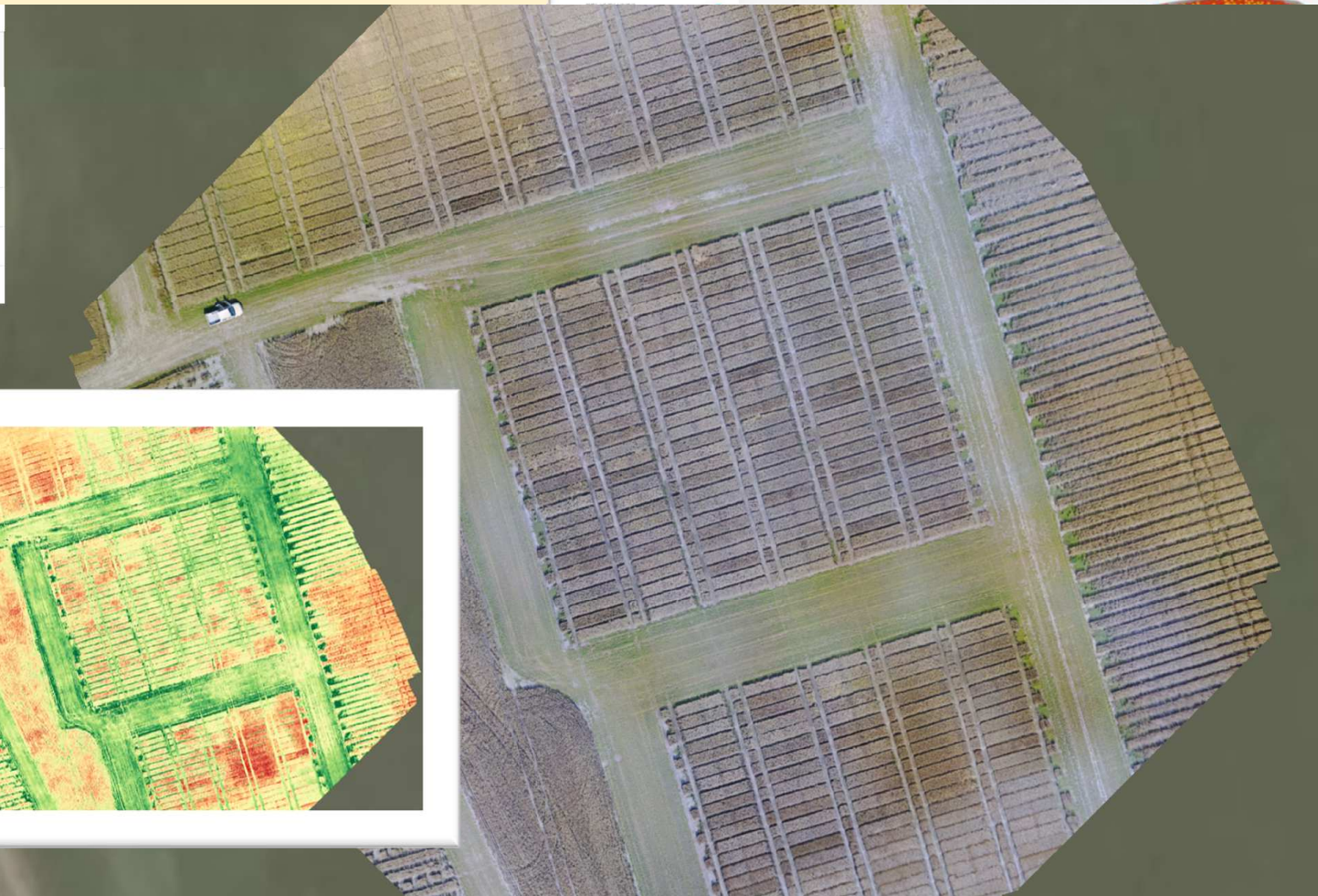
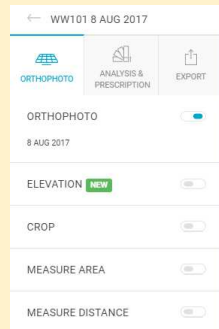
Image  
handling  
platforms

# The Solvi Platform

Processing: As simple as the other two

Image  
handling  
platforms

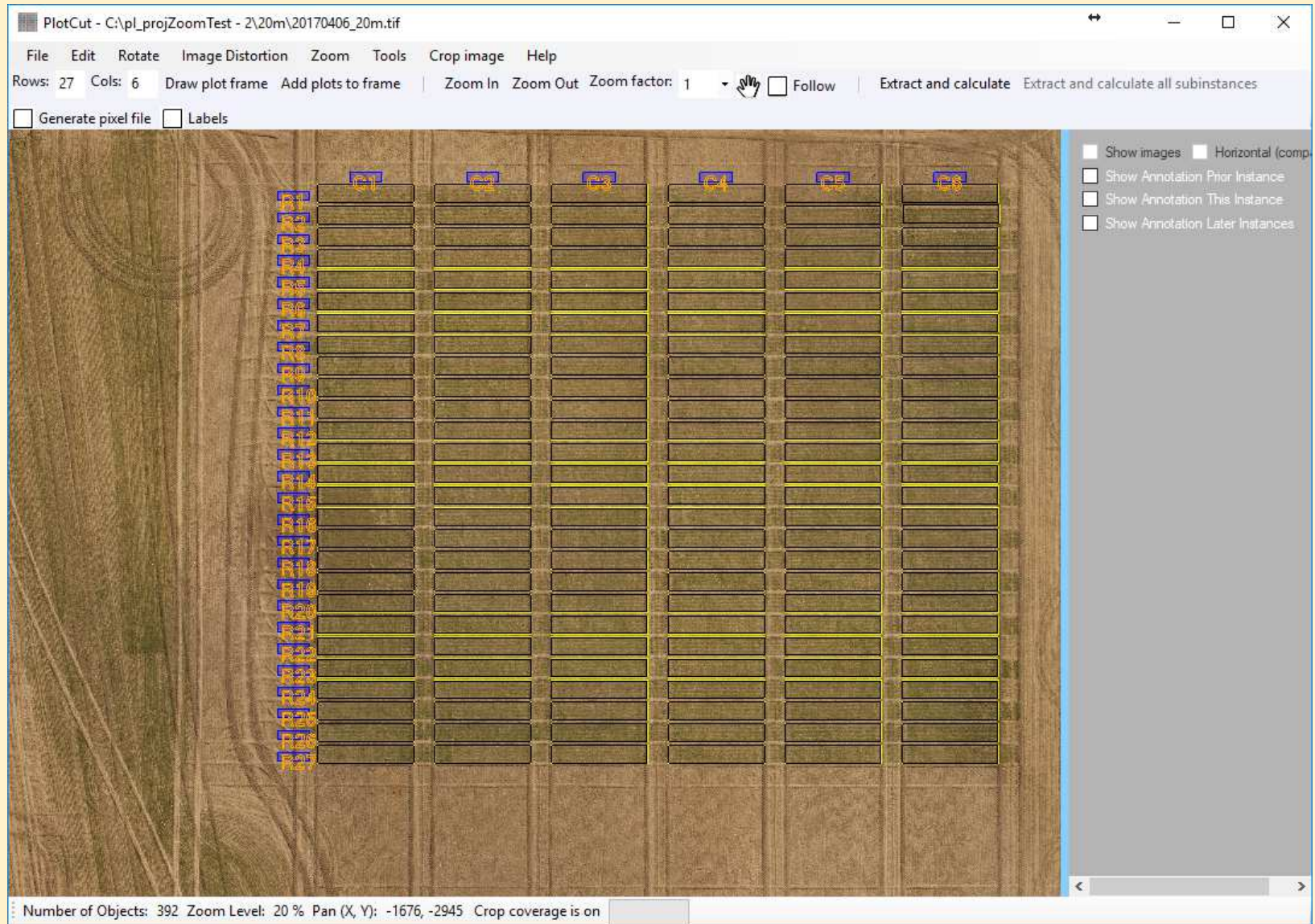
# The Solvi Platform



Next platform...

Image  
handling  
platforms

# The PlotCut 2 Platform, from 6P



# The PlotCut 2 Platform

## Features:

- Very precise manipulation of plot extraction areas
- A field trial is a project
- Easy re-use of extraction grid through temporal instances
- Detailed output (plot and pixel level) for further analysis
  - Individual image slices
- Annotation (also in some of the online platforms)

## Lacks:

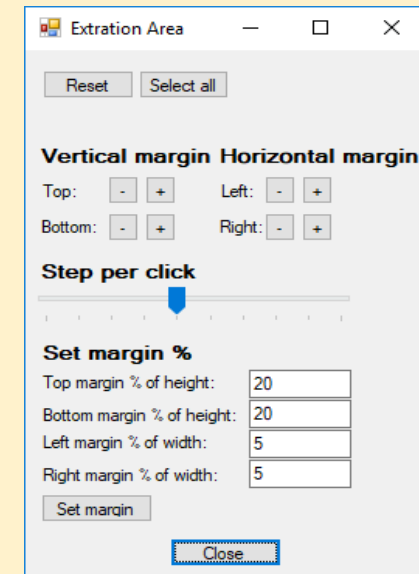
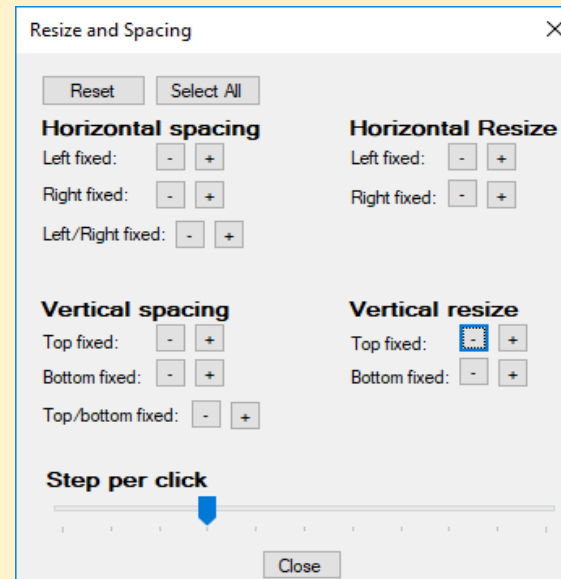
- Georeferencing
- Using your own apps/add-ons

Image  
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platforms

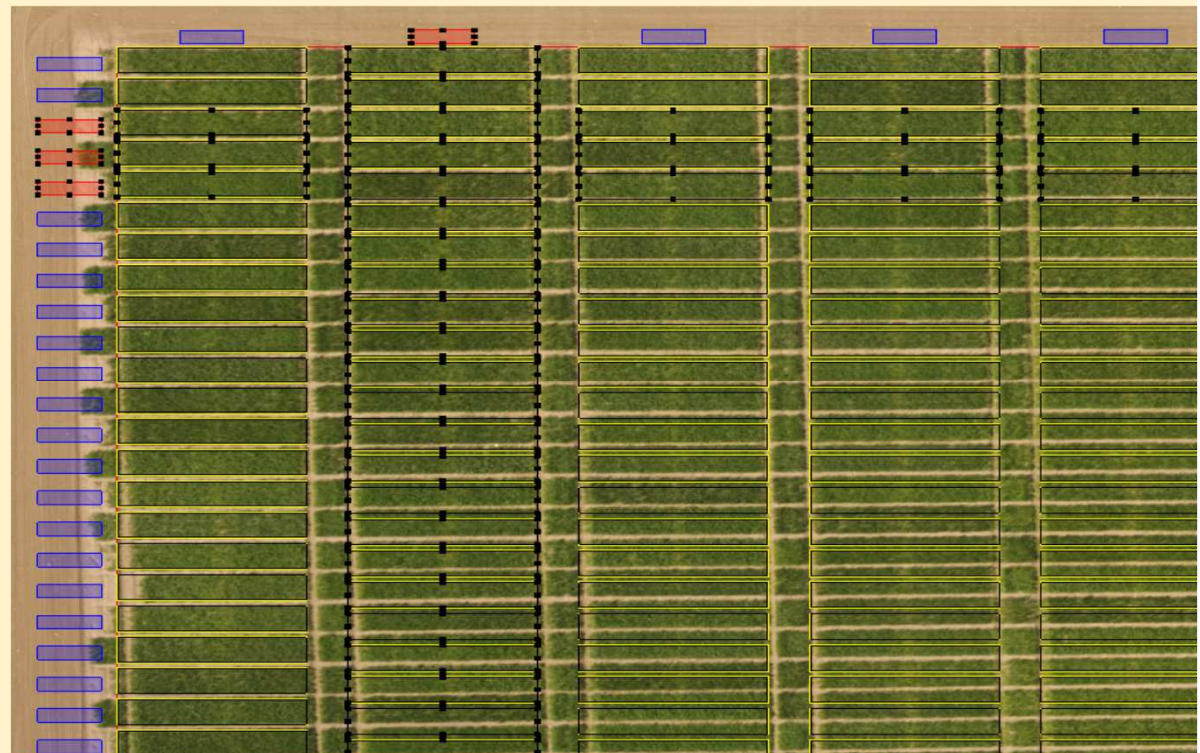
# PlotCut 2

## Processing:

- No mosaic processing
- just plot extraction



	C6_R24_-__.png	25,3 KB	PNG image
	C6_R24_-__.png_bw.jpg	867 bytes	JPEG image
	C6_R25_-__.png	24,4 KB	PNG image
	C6_R25_-__.png_bw.jpg	867 bytes	JPEG image
	C6_R26_-__.png	25,1 KB	PNG image
	C6_R26_-__.png_bw.jpg	867 bytes	JPEG image
	C6_R27_-__.png	24,7 KB	PNG image
	C6_R27_-__.png_bw.jpg	867 bytes	JPEG image
	calc_positions.csv	3,58 KB	Microsoft Excel Comm
	decSepComma.csv	40,9 KB	Microsoft Excel Comm
	decSepPeriod.csv	40,9 KB	Microsoft Excel Comm
	logfile.txt	29,2 KB	Text Document



# Input support in the platforms\*

- Images, as bitmaps
  - Compressed, some quality loss: **JPEG**
  - Compressed, no quality loss: **PNG, TIFF**
    - **RGB**
    - **Single greyscale color (multispectral, thermal)**
  - Uncompressed: **RAW** – extra processing possible before mosaic
  - Videos: e.g. **MPEG** (extracting some of the images for use)
- Models
  - Point clouds (LAZ, LAS)
- Delineations/boundaries, as vectors
  - SHP and other formats

\* Not all the platforms accept the same input

# Advanced input support

- Geo accuracy improving input: GCPs (Ground Control Points)
- Models
  - Point clouds (LAZ, LAS)

# Now wait a moment !

Some platforms can more than just process images and analyze mosaics

## Flight planning

- DroneDeploy's →
- PrecisionHawk's Flight (pro)

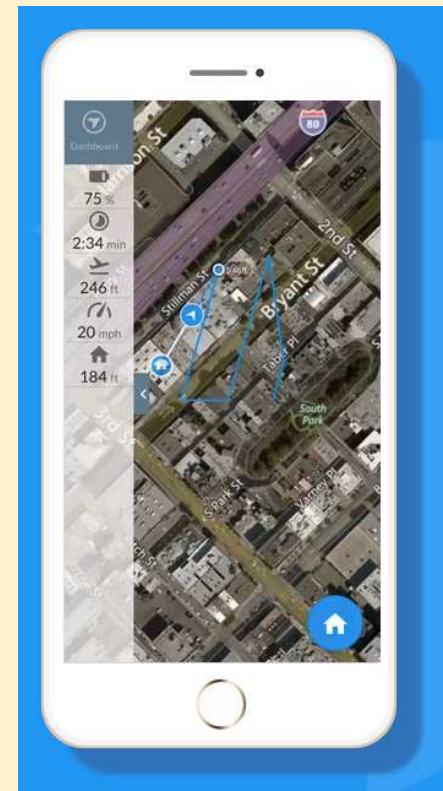


Image  
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# What does it cost?

All prices in converted to euros (2018 11)	Monthly / Yearly (notice: Any full year rebates are included)	Pay as you go	Extras
Pix4D Mapper	260 / 2600	-	-
Pix4D Fields	190 / 1900	-	-
Agisoft Photoscan € 3100 for keeps	-	-	-
DroneDeploy: Pro Business	115 / 875 350 / 2630	-	App market GCPs € 45 per map
PrecisionMapper: Free Professional	(5 RGB a month) - / 3100	-	App market
Solvi	300 / 1900	e.g. 5*mosaic €50	Plant count €100
PlotCut 2	Free for 6P R&I	-	-
PlotCut 2 light	Free for NPPN	-	-
PlotCut 3 (QGIS, PostGIS etc)	?	-	-

# Discussion

- What do you as breeders need, to better work with drone data in a good workflow?
  - For image analysis?
  - For subsequent data analysis?

# PlotCut 3 ... The next PlotCut

- Based on using QGIS
  - Free, open source software
  - Will be a plugin to QGIS
  - Will be a lot more advanced than PlotCut 2
    - Geostatistical tools; spatial variability
    - Temporal variability/dynamics
    - E.g. remove the soil components
    - Include R—scripts from Signe (and others)
    - Lots of knowledge layers
      - Soil maps
      - Climate input
    - Incorporate machine learning (The Orfeo Toolbox)
  - Will also be a lot more complex (at least with the potential)
  - Possibility for other plugins along the way; workflow logic etc

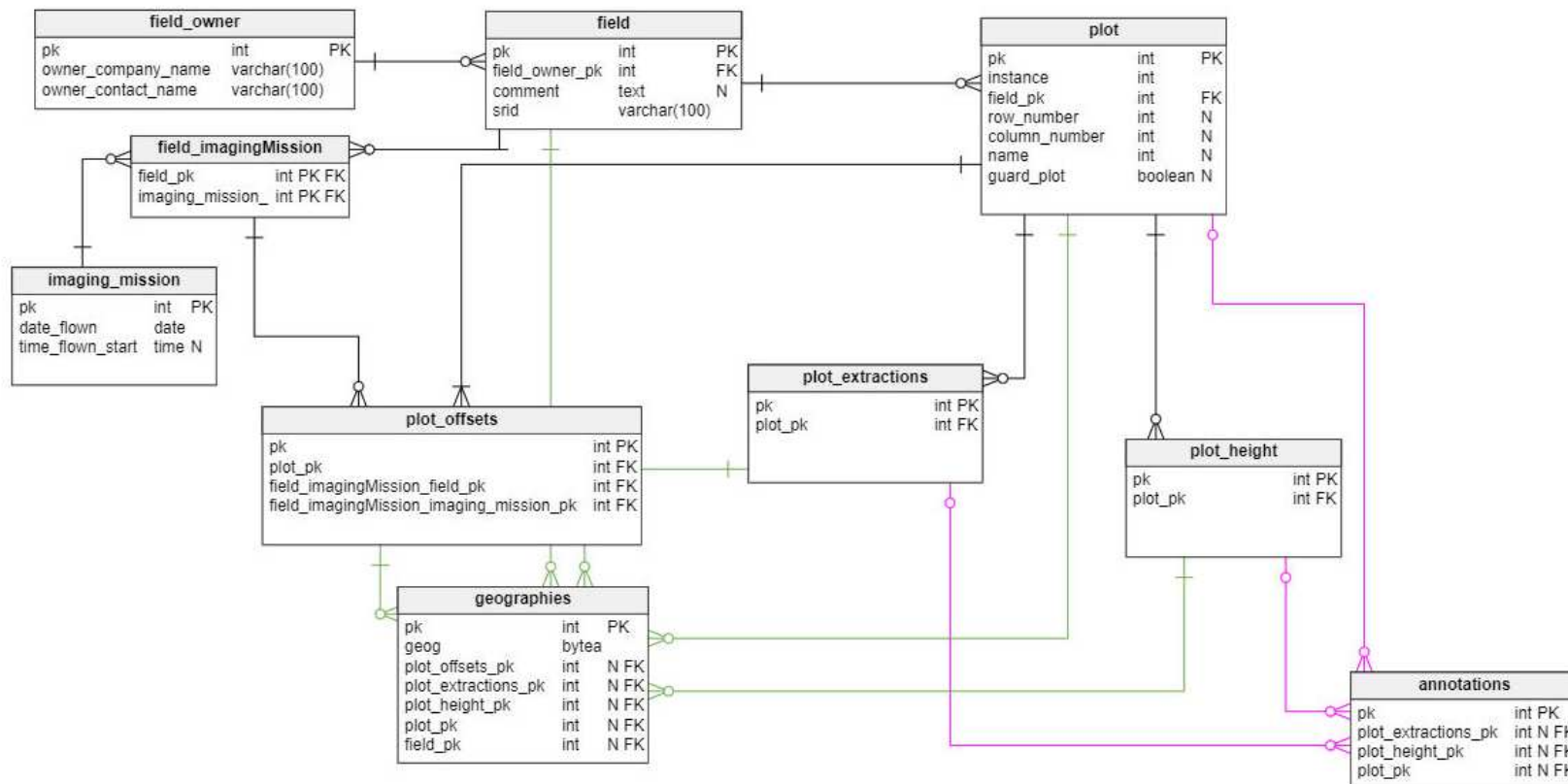
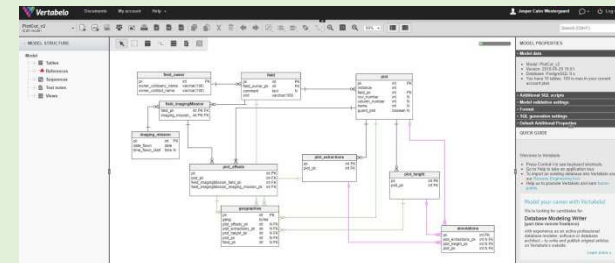


# QGIS and PostGIS



- What is PostGIS
- Why in a database?
  - You the 6P2 breeders can get the data continuously
  - The database can be
    - locally on the same computer as the QGIS installation
    - OR accessible from e.g. both Store Heddinge and Kentucky and New Zealand
  - You can set up your own system.
    - After all. It's free and open source
    - Relatively easy to find people/companies that can build a connection to your data structure.

# QGIS and PostGIS



# Credits: Thank you to...

- The Drone Team at Taastrup Campus
  - Jesper, Signe, Jesper, Saiful, Jon
- The 6P project leader and administration
  - Svend, Mira, Lene, Birgitte
- Our 6P partners that dare to try new hard- and software
  - DLF, Danespo, Graminor, Lantmännen, Secobra, Sejet, SLU



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