

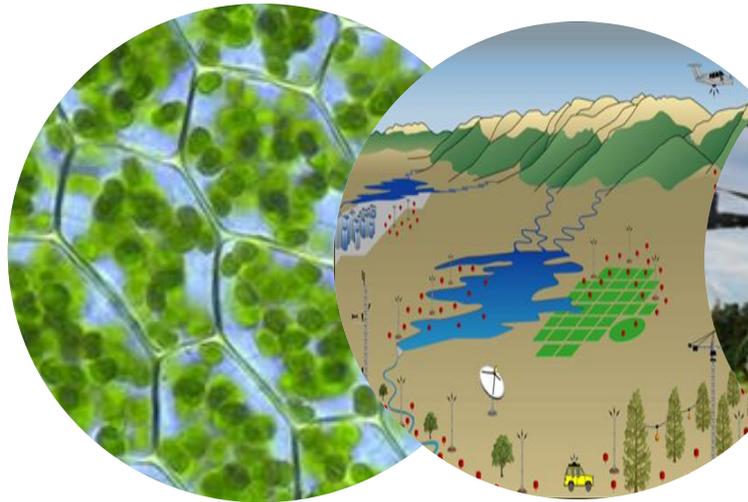
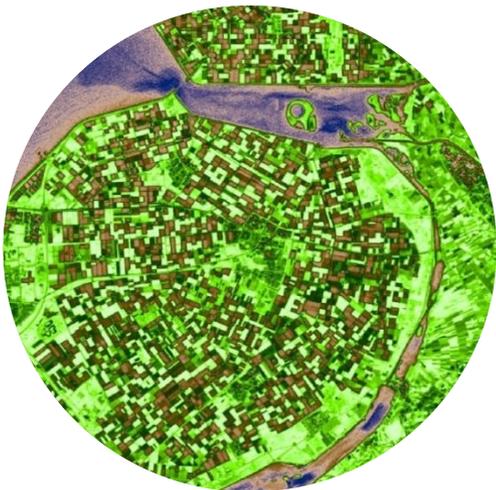
Unmanned Aerial Systems: Smart Inspectors for Environmental Monitoring Applications

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1: Laboratory of Geo-Information Science and Remote Sensing-Wageningen University

2: Soil Physics and Land Management – Wageningen University

3: Alterra, Wageningen, The Netherlands

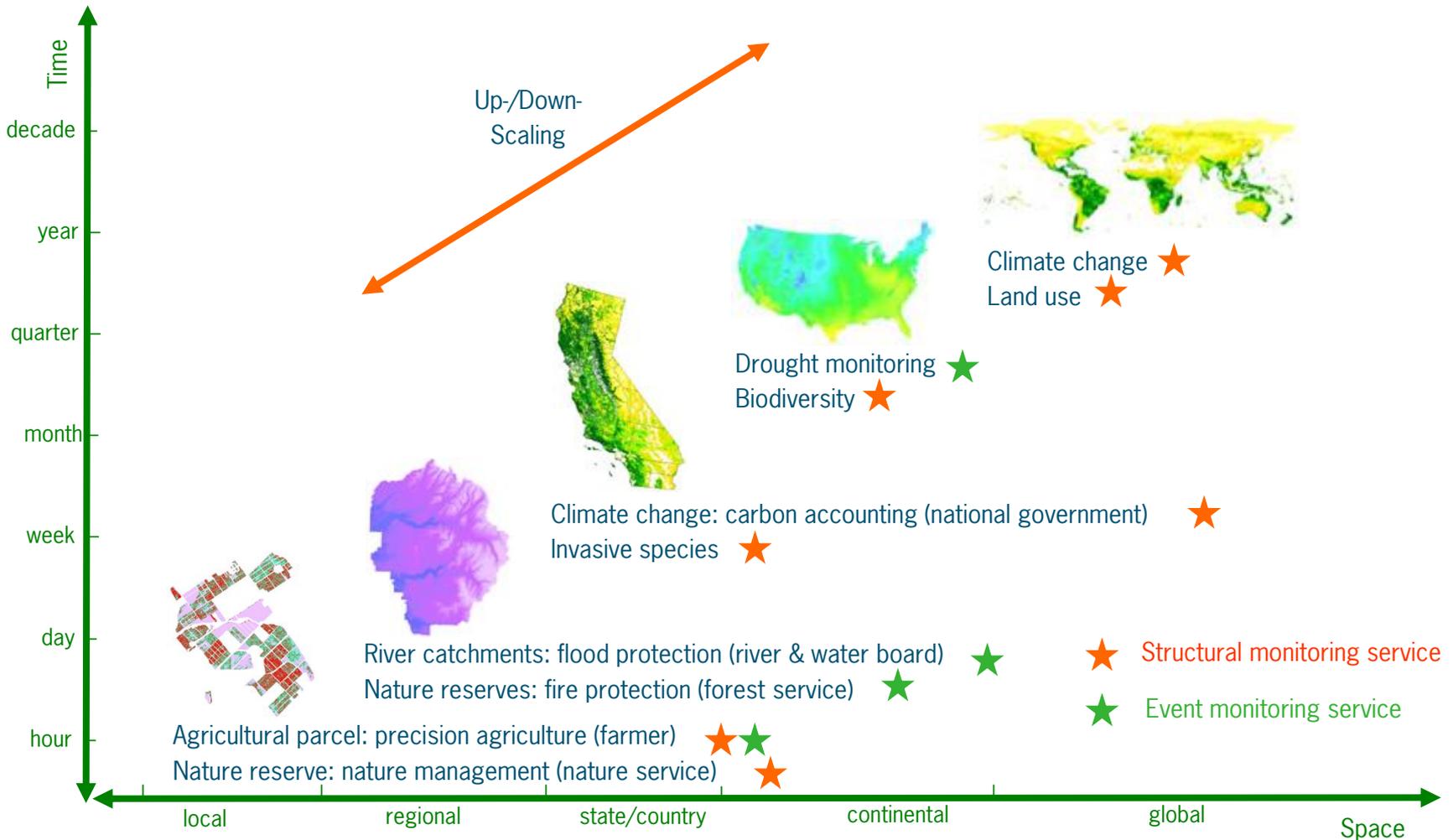


Outline

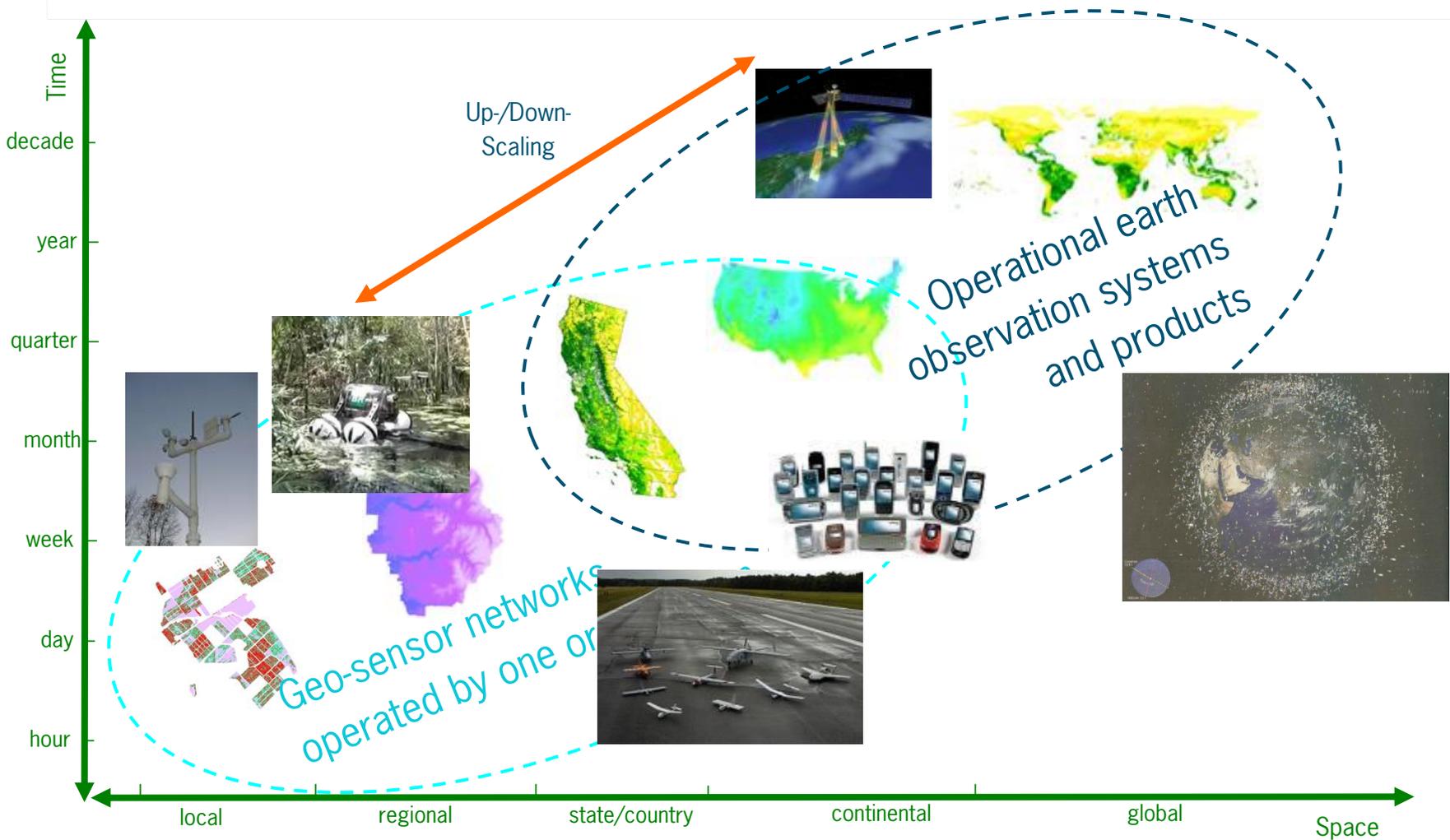
- Role of UAS in Environmental Monitoring
- UAS Research Facility in Wageningen and HYMSY
- Precision Agriculture
 - Case studies
 - Future scenario's
- Outlook UAS as future Smart Inspectors



Environmental monitoring



Developments in sensing technology



Why UAS: closing the gap

Satellite



Plane



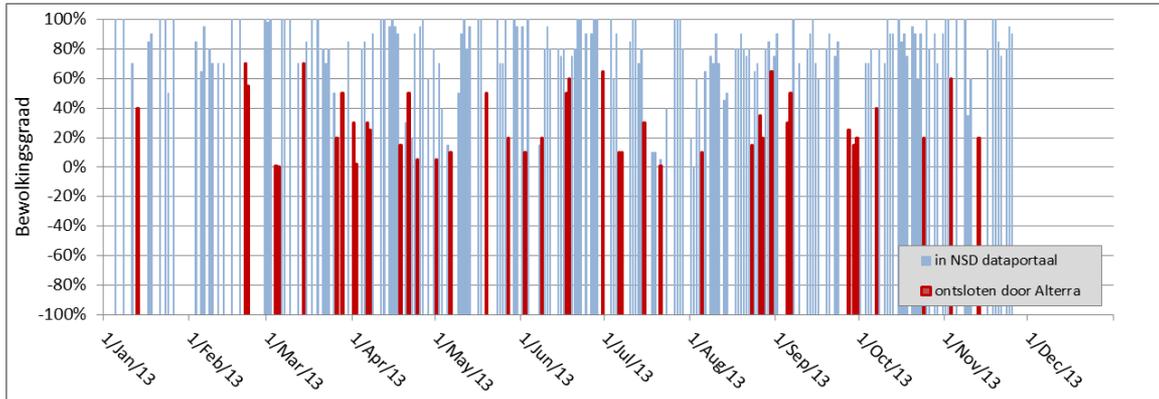
UAS/drones/RPAS



Ground-based



Why UAS: flexibility



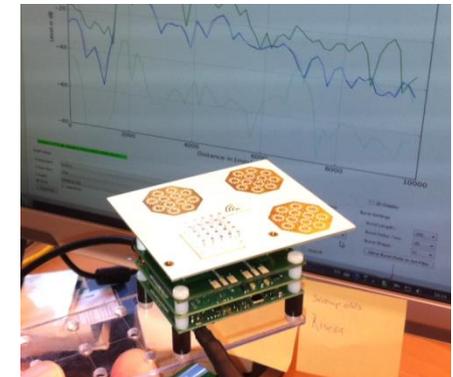
Close data availability gaps



Use the complete EM spectrum



Increase spatial detail



Courtesy: IMST



WAGENINGEN UNIVERSITY
WAGENINGEN UR



Unmanned Aerial Remote Sensing Facility@WUR

Objectives Research Facility:

- Platform for dedicated and high-quality experiments
- Calibration facilities and disseminating processing procedures to the UAS user community
- Test use in range of applications like habitat monitoring, precision agriculture and land degradation assessment

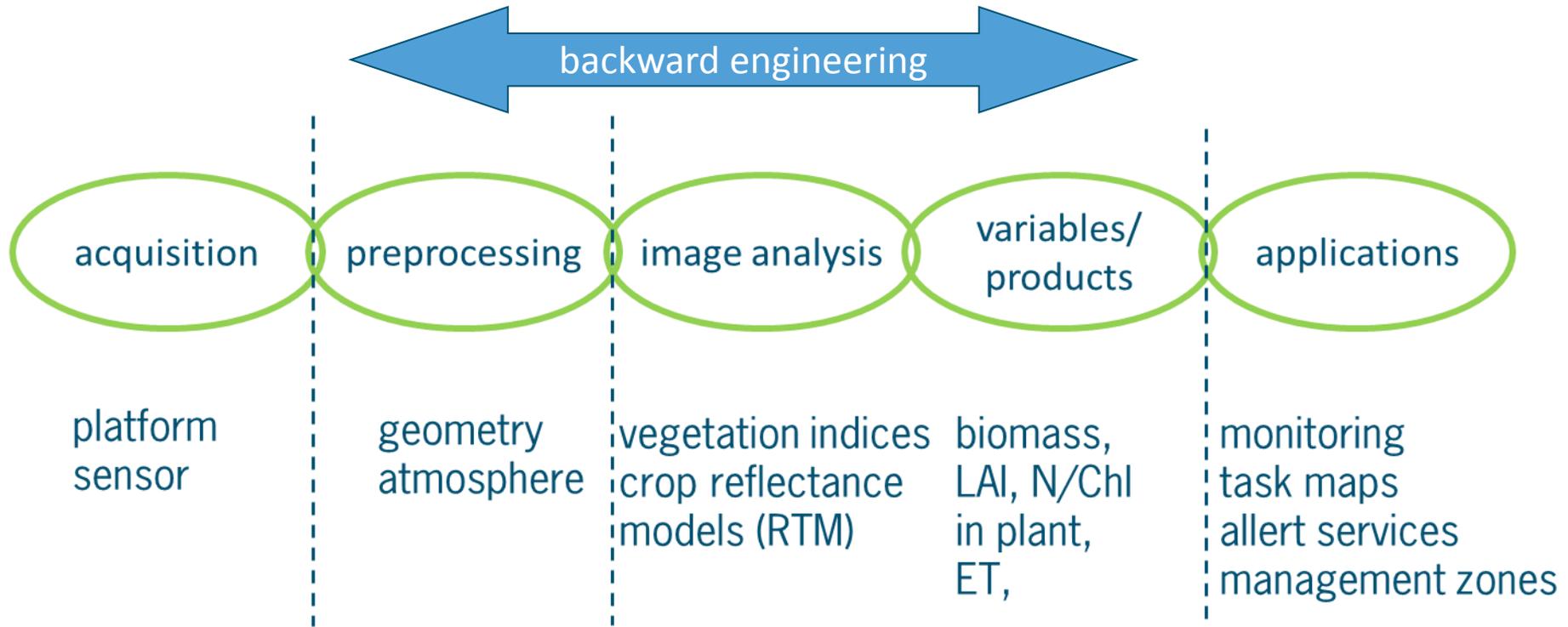
Our pilots



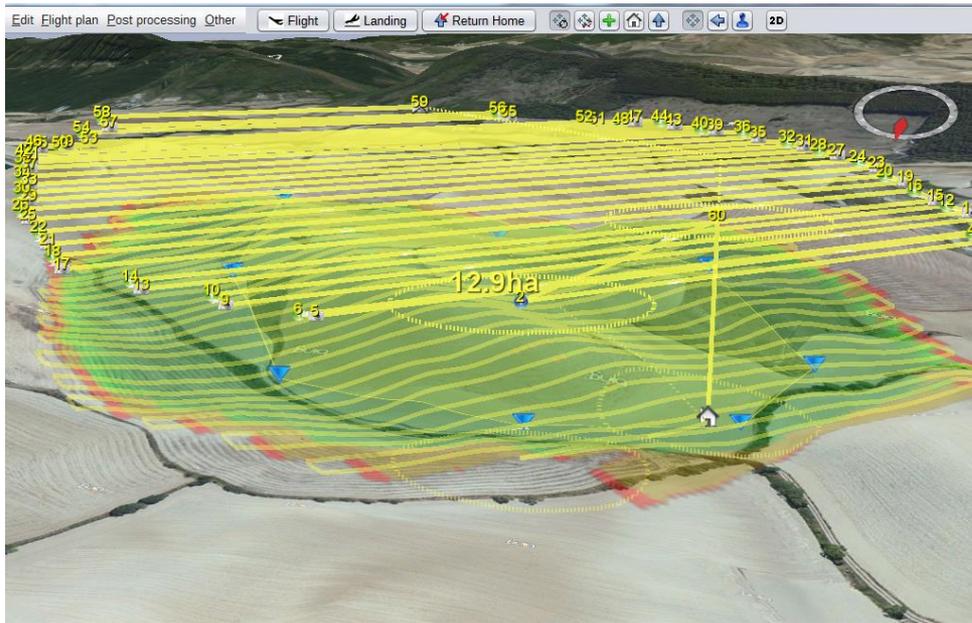
Our platforms



Remote Sensing Science: UAS in a chain



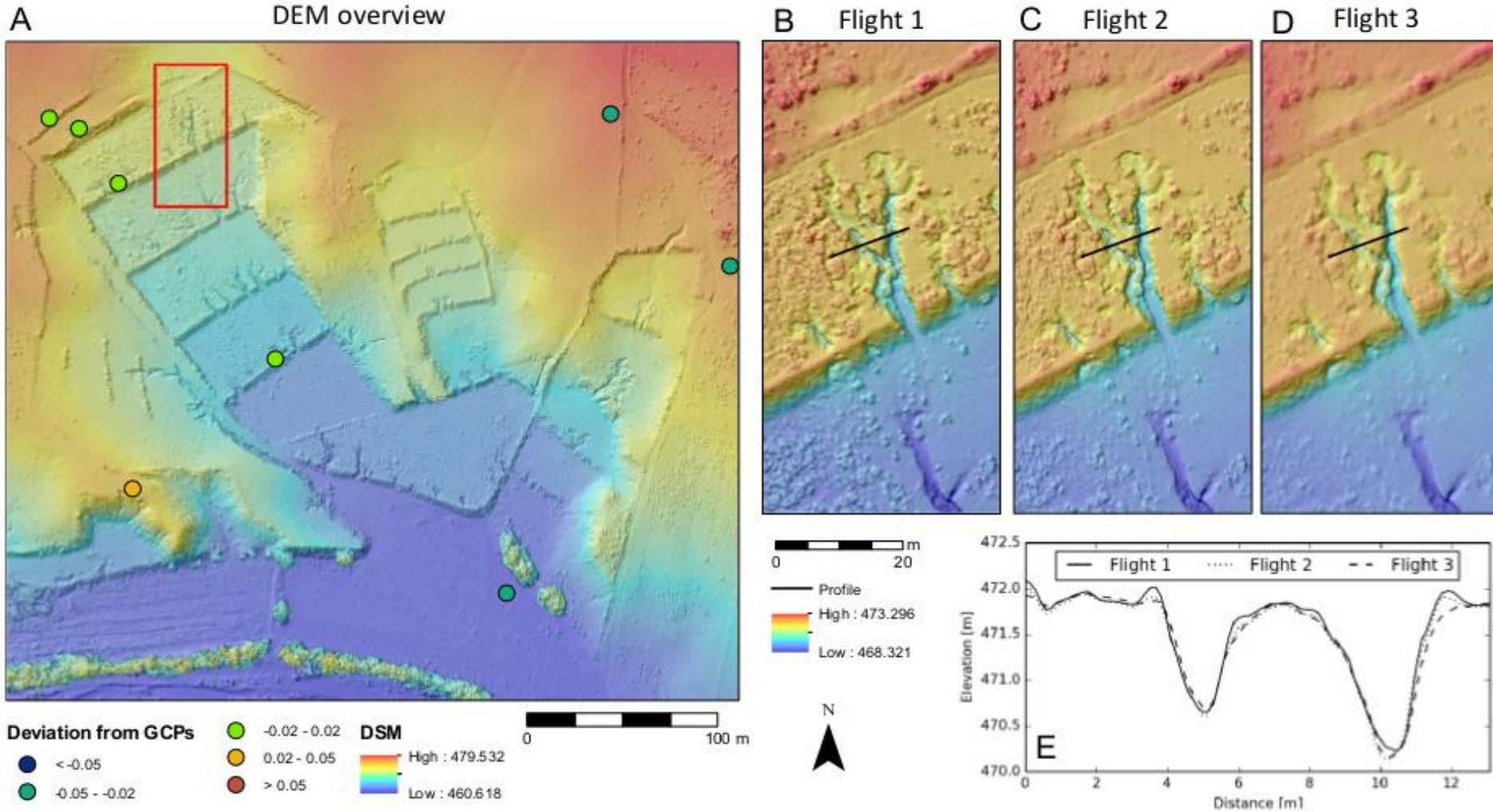
Flight planning



- Flight planning software
- On the basis of GPS
- Pilot monitors the flight, and does take-off and landing



Soil erosion mapping

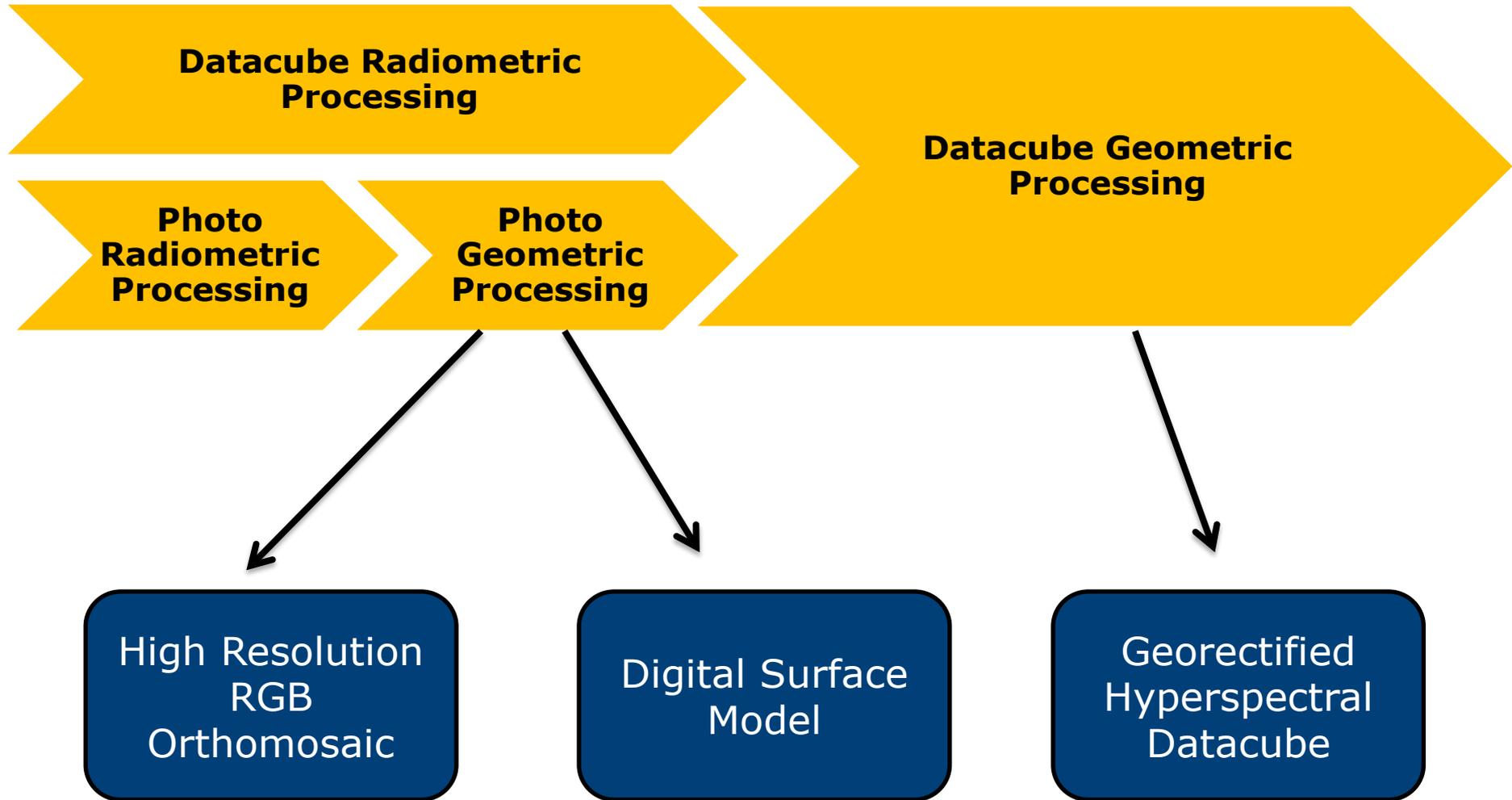


Hyperspectral Mapping Concept

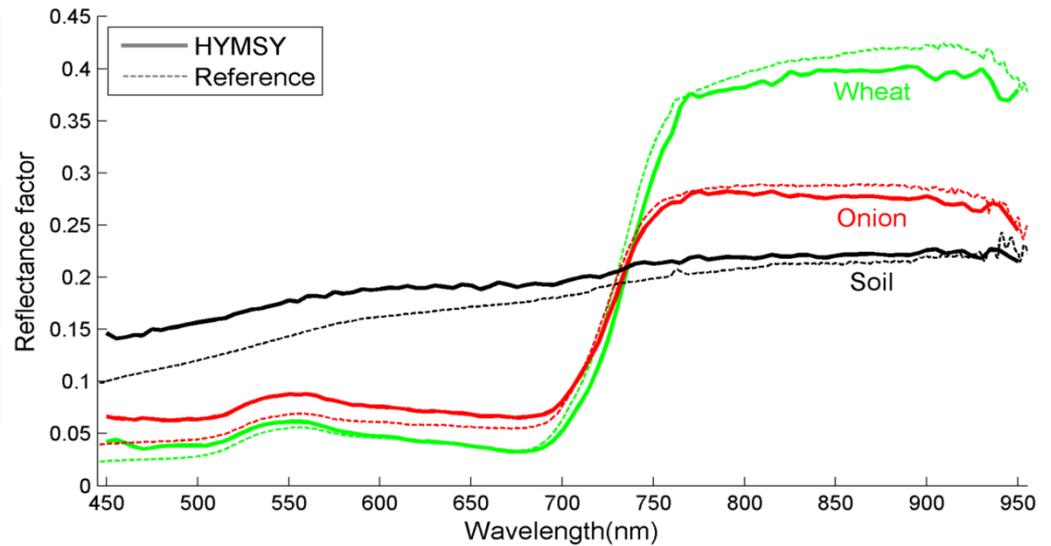
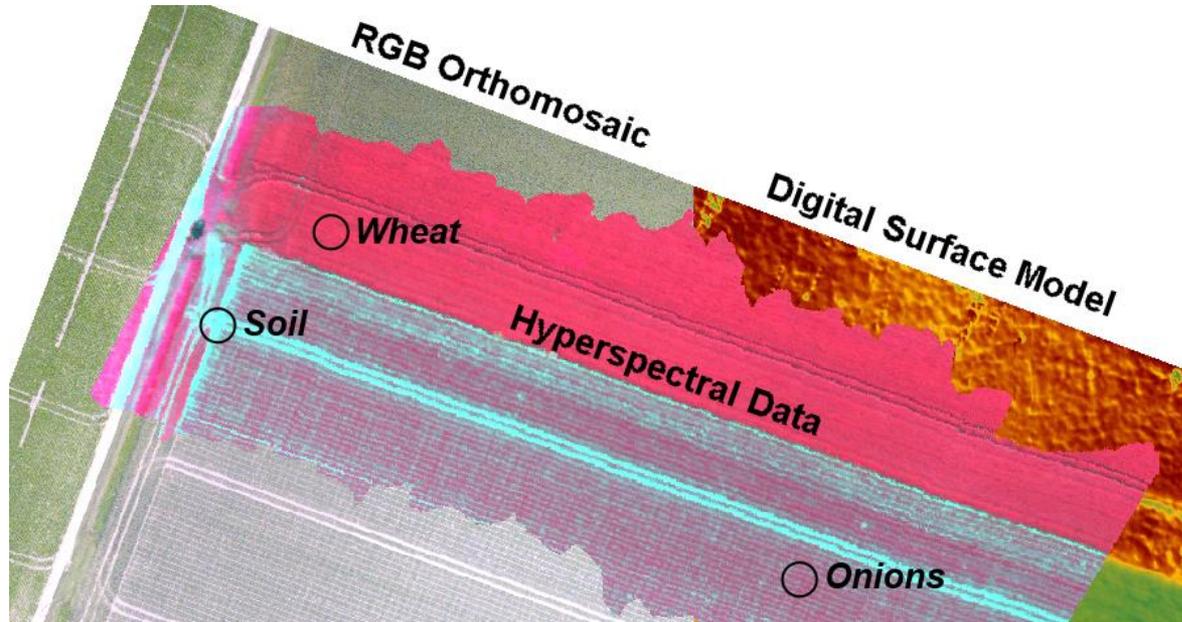
- Aerialtronics Altura AT8
 - Programmable autonomous flight
 - 2kg payload
 - 5-10 min flight time
- Pushbroom spectrometer
 - 450-950nm
 - FWHM 9nm
 - 20 lines/s
- Consumer RGB camera
- GPS/Inertia navigation System
 - Accuracy: 4m / 0.25°



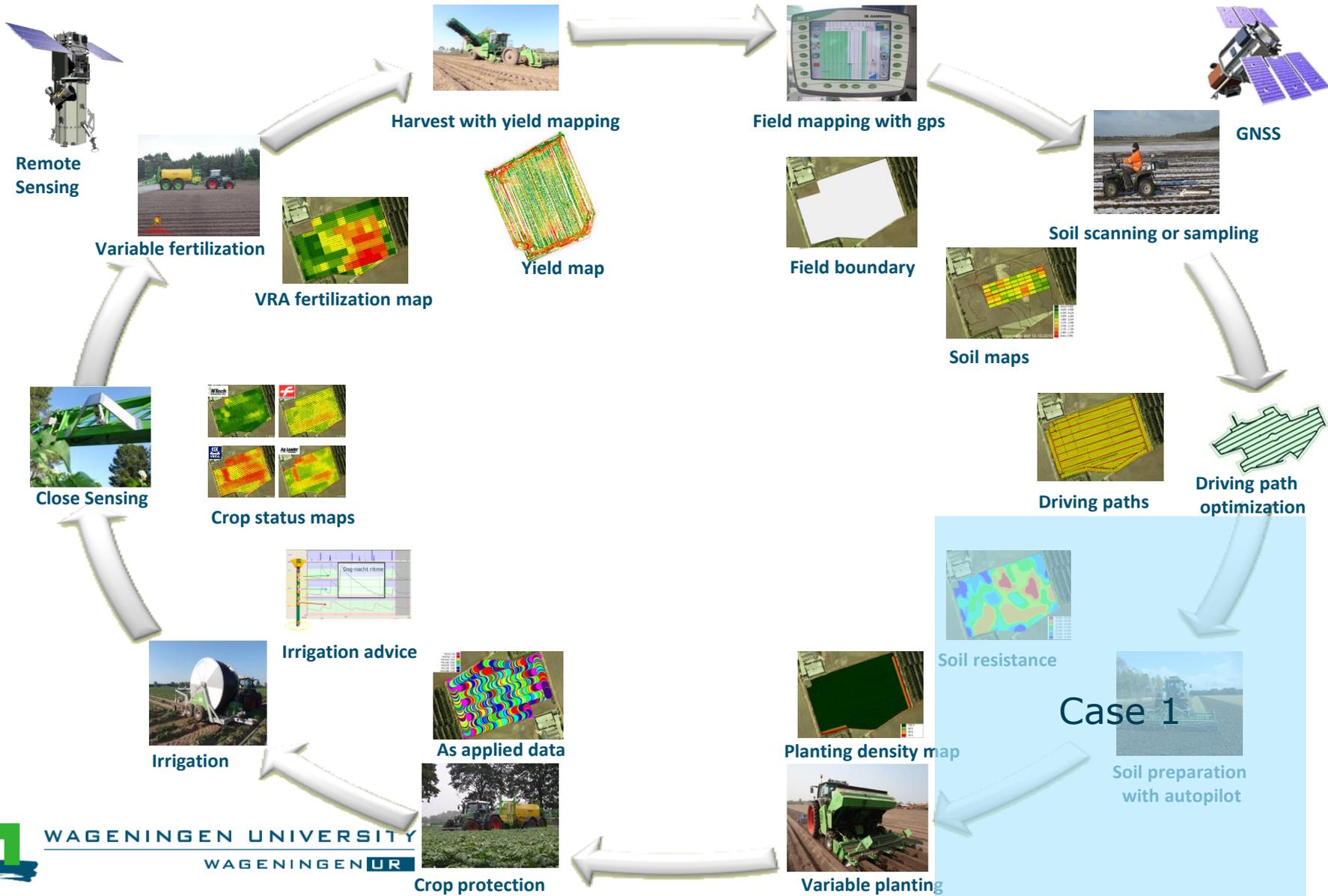
Overview of processing chain



Result Experimental Field Dronten

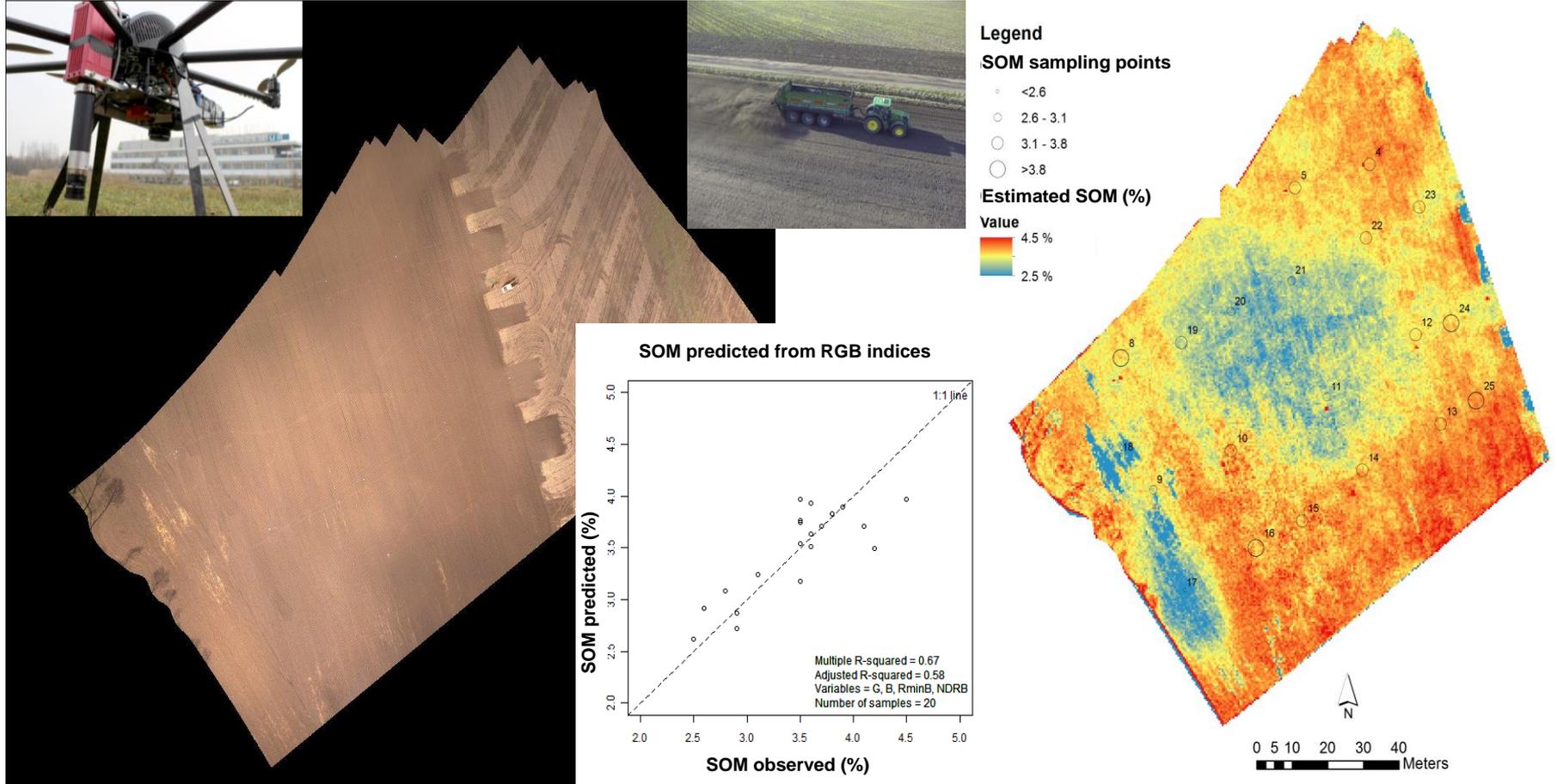


Precision agriculture cycle



Case study 1: Soil preparation

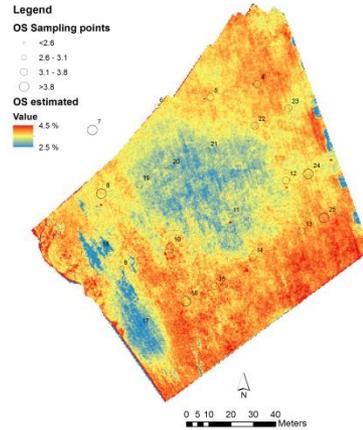
Assessment of soil organic matter status



Future scenario: environmental microscope

UAS mapping system:

- Quantitative modelling
- Onboard/cloud processing
- Communication with other platforms



Soil property distribution map
(also water quality monitoring)



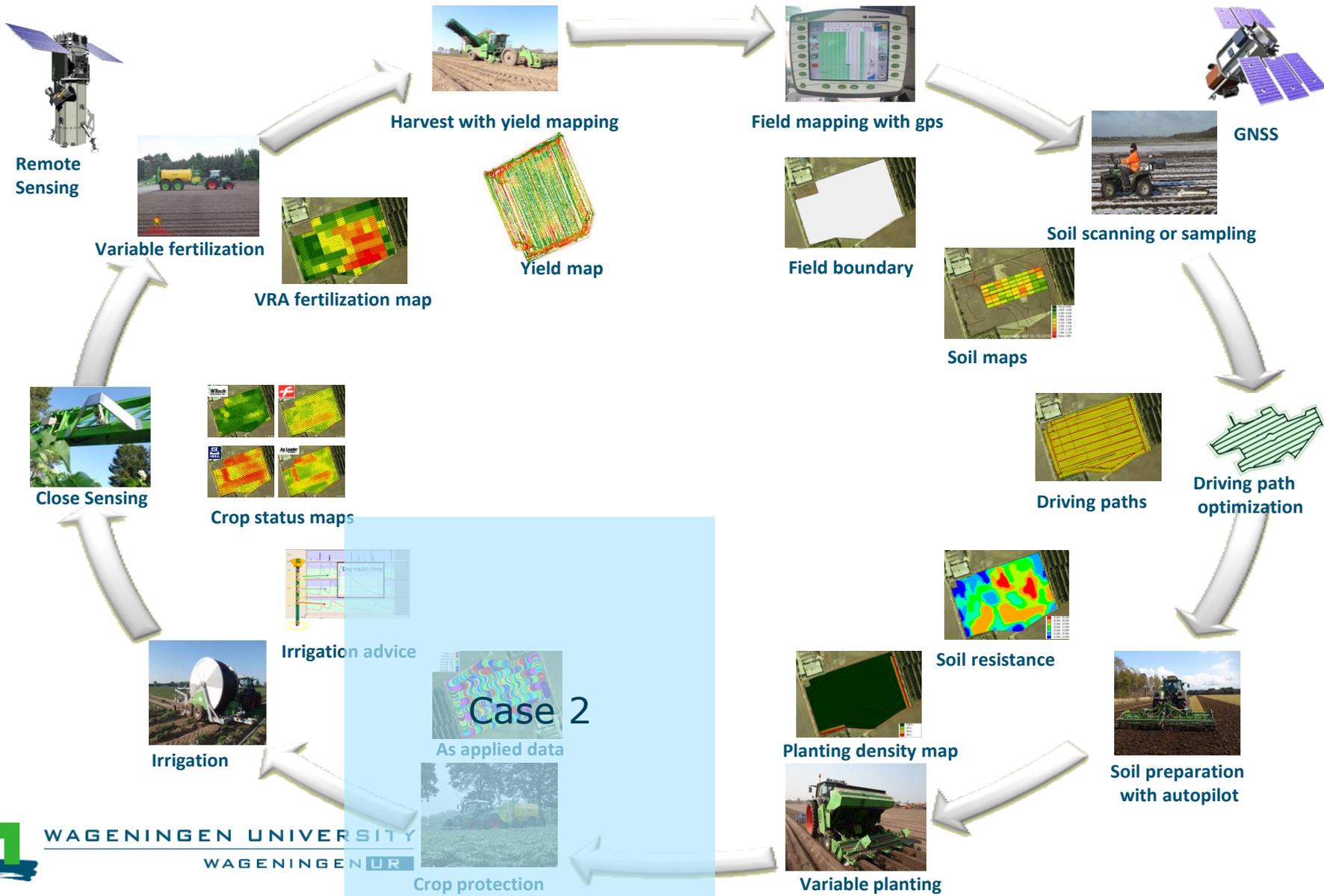
Rapidprobe Rtv equipped with Gps and autosteer



Homogenous management units

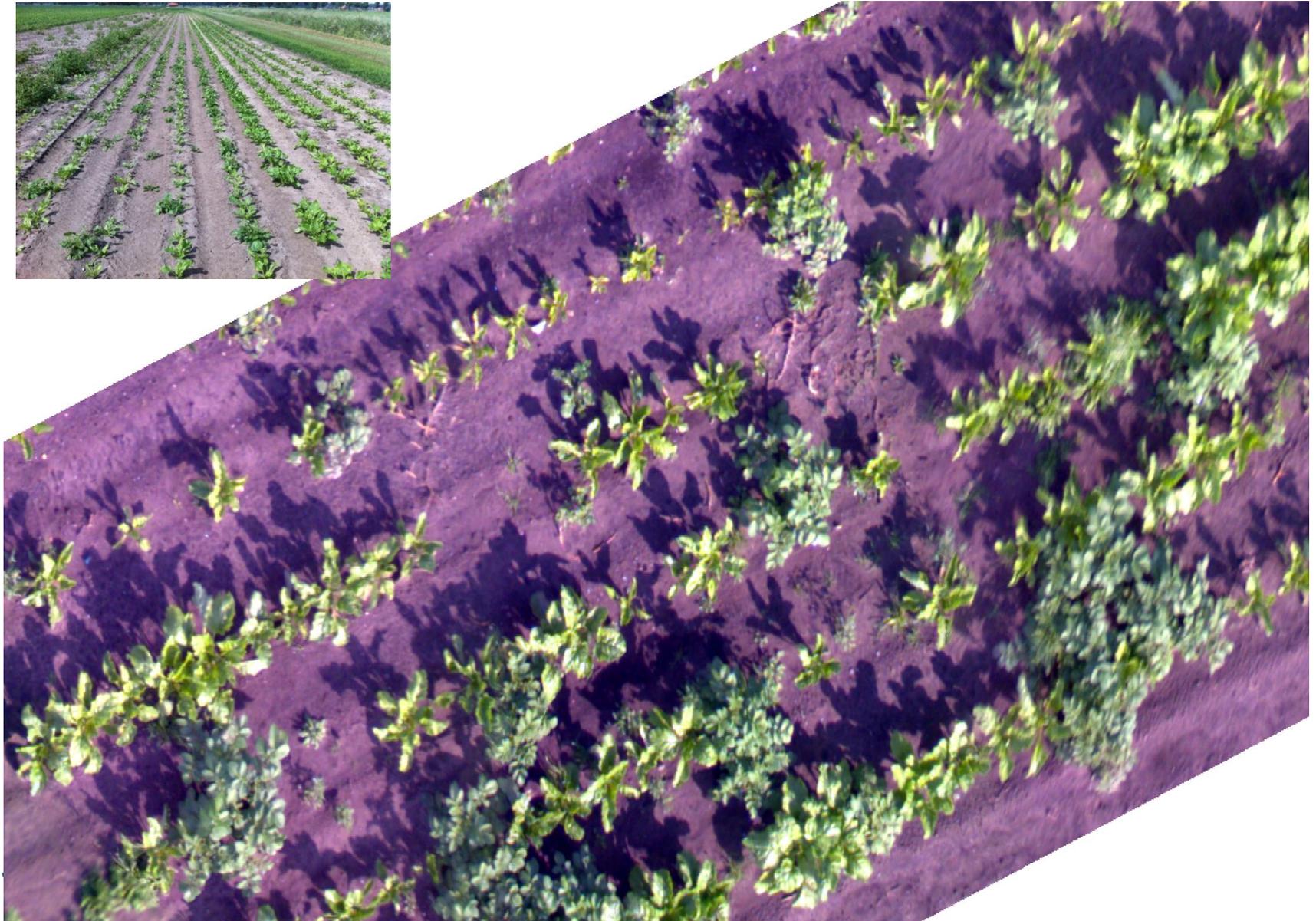


Precision agriculture cycle



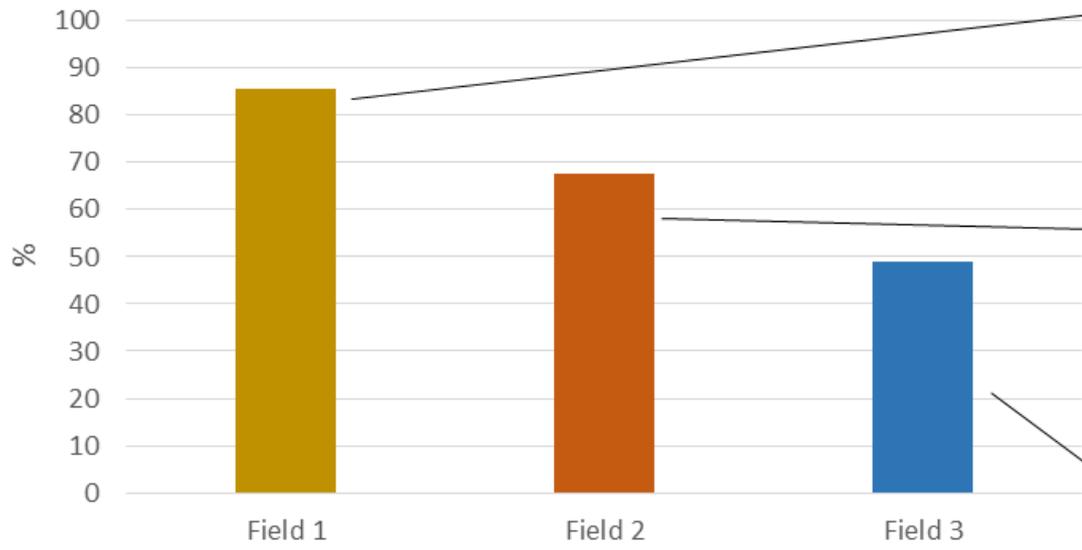
Case study 2: Crop protection

Potato in sugar beet field

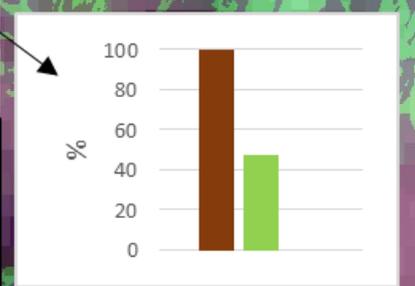
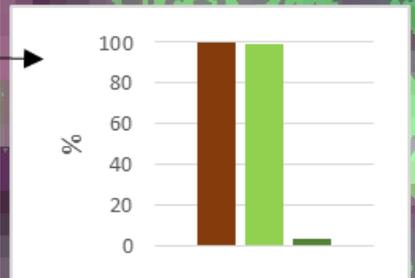
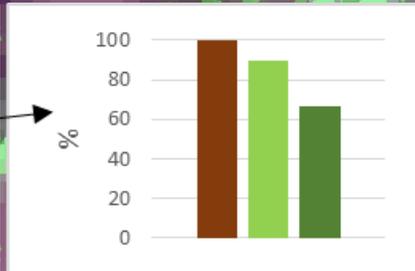




Greenness index



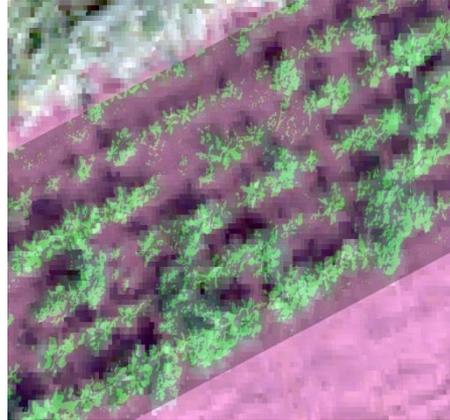
- Bare soil
- Potato
- Sugar beet



Future scenario: team worker

UAS mapping system:

- Machine vision algorithms
- Onboard/cloud processing
- Communication with other platforms



Crop protection task map



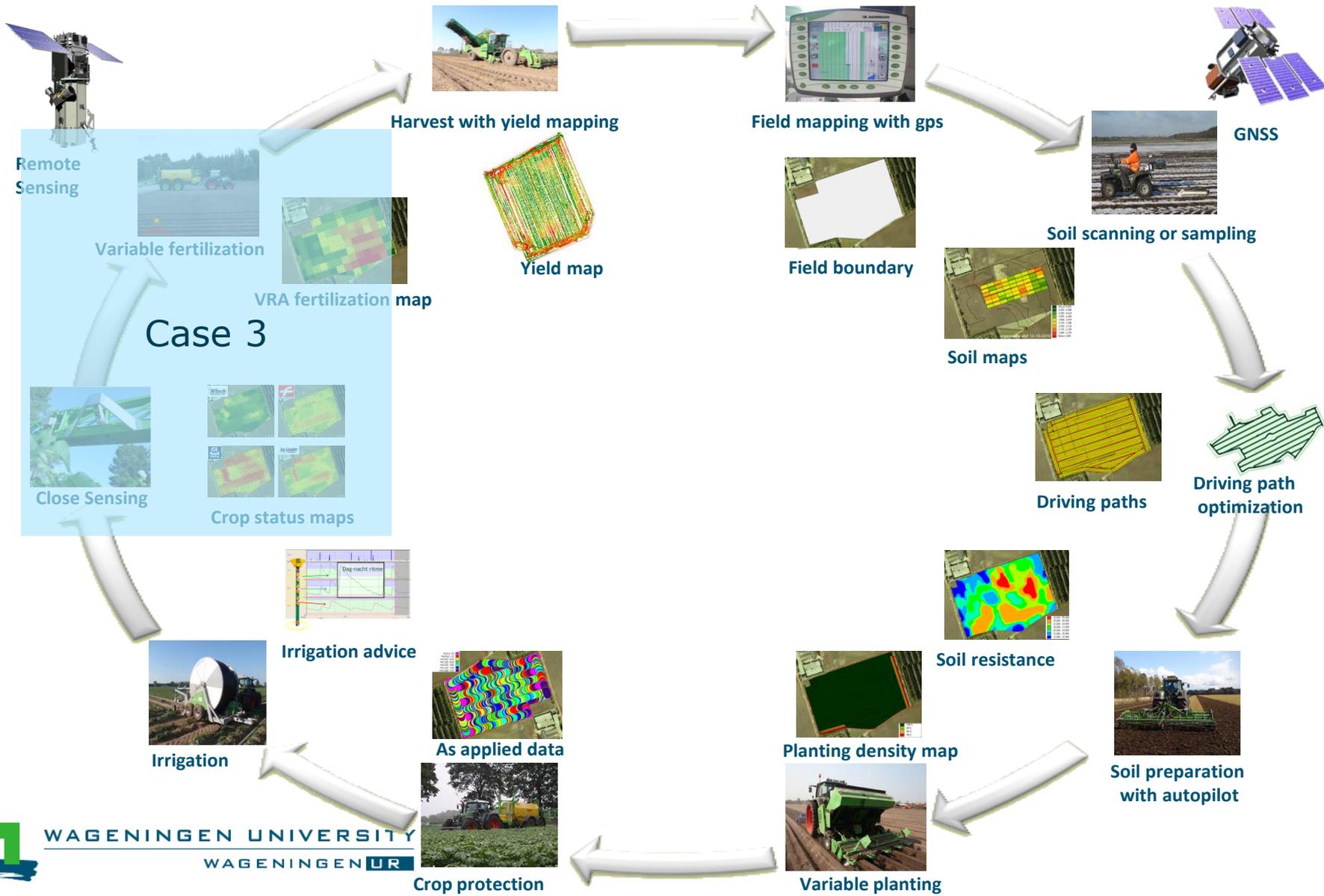
Yamaha RMax remote-controlled helicopter



Unmanned Ground-based Vehicle

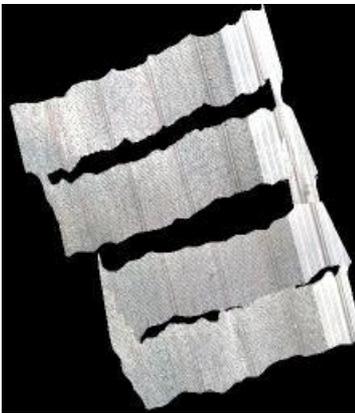
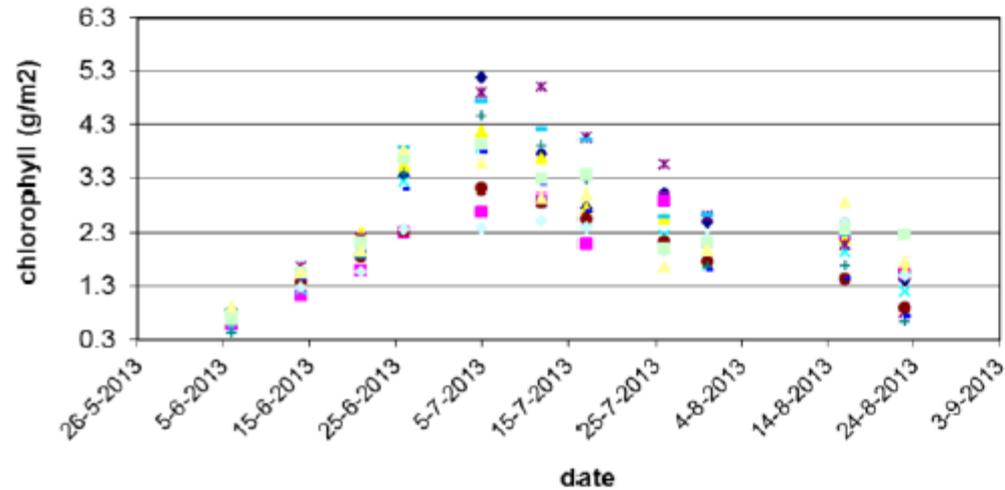


Precision agriculture cycle

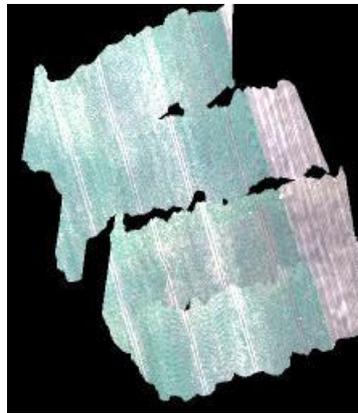


Case 3: Crop status monitoring

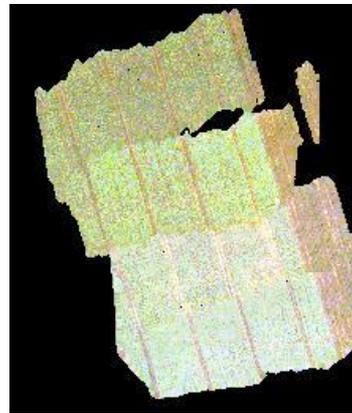
Fertilization management potato



June 6



June 14



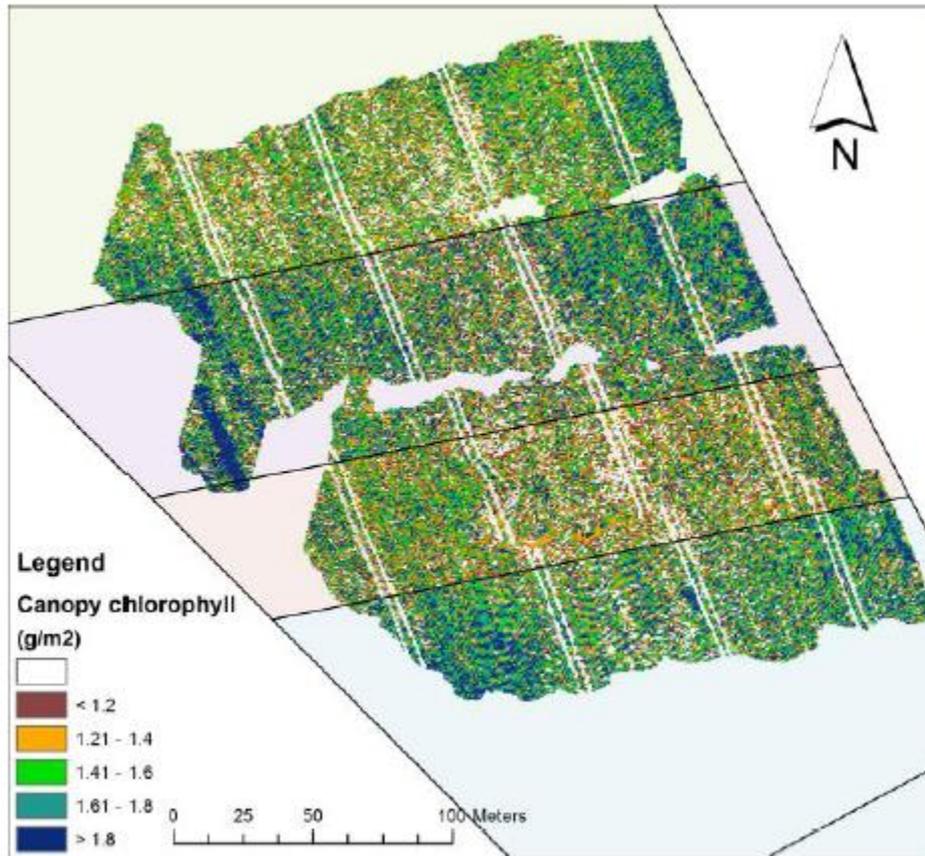
July 5



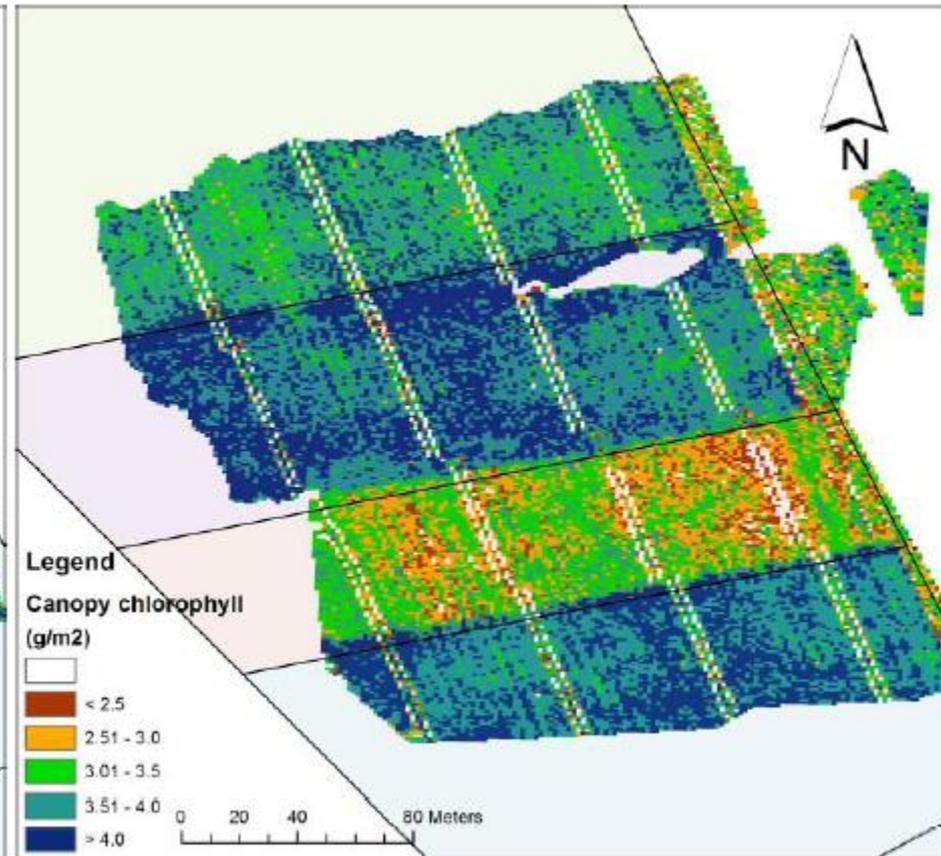
July 17



Over growing season: crop monitoring



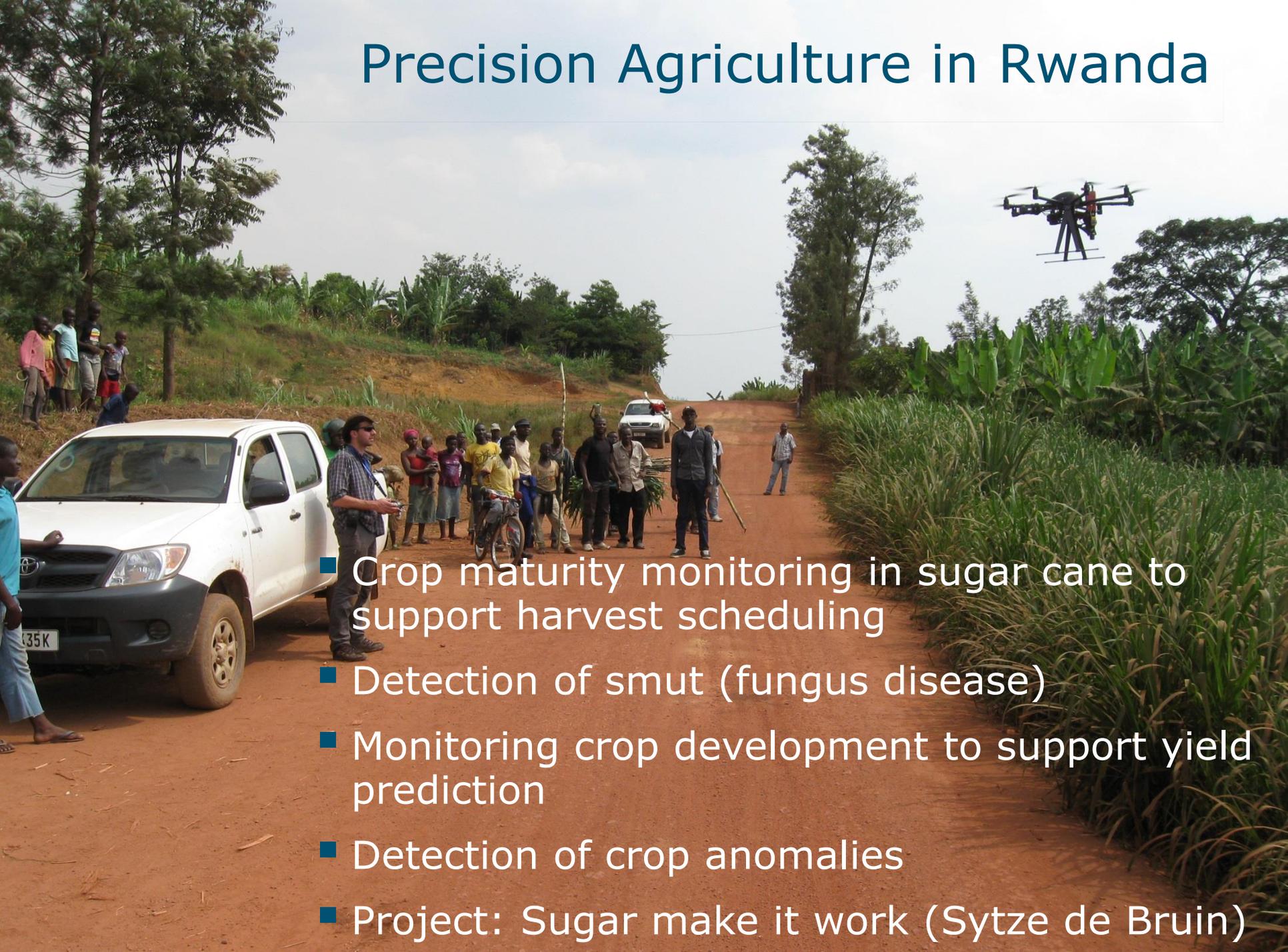
June 14, 2013



July 5, 2013

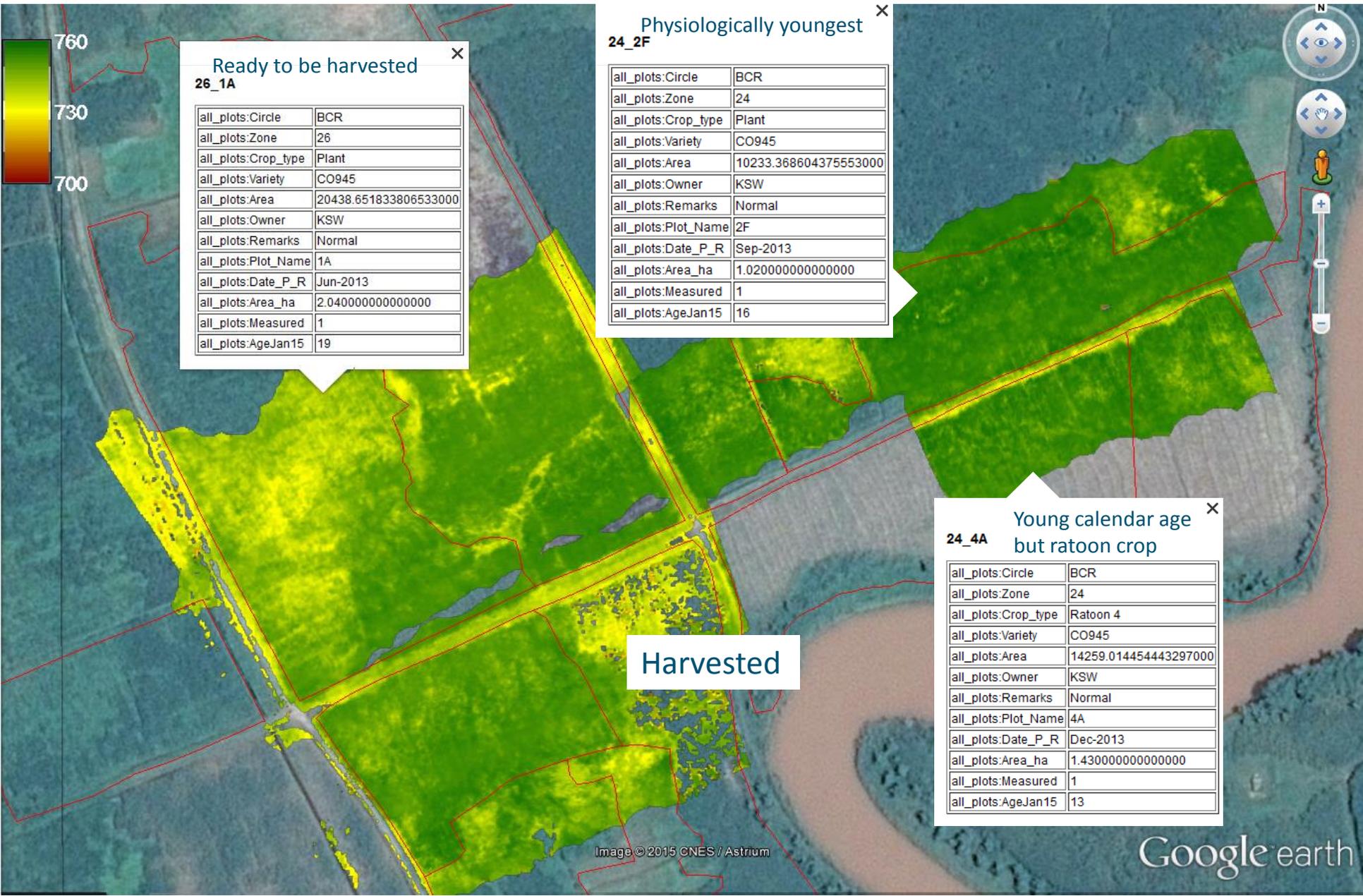


Precision Agriculture in Rwanda



- Crop maturity monitoring in sugar cane to support harvest scheduling
- Detection of smut (fungus disease)
- Monitoring crop development to support yield prediction
- Detection of crop anomalies
- Project: Sugar make it work (Sytze de Bruin)

Example: red-edge position vs. crop age



Harvested

Future scenario: Field scout

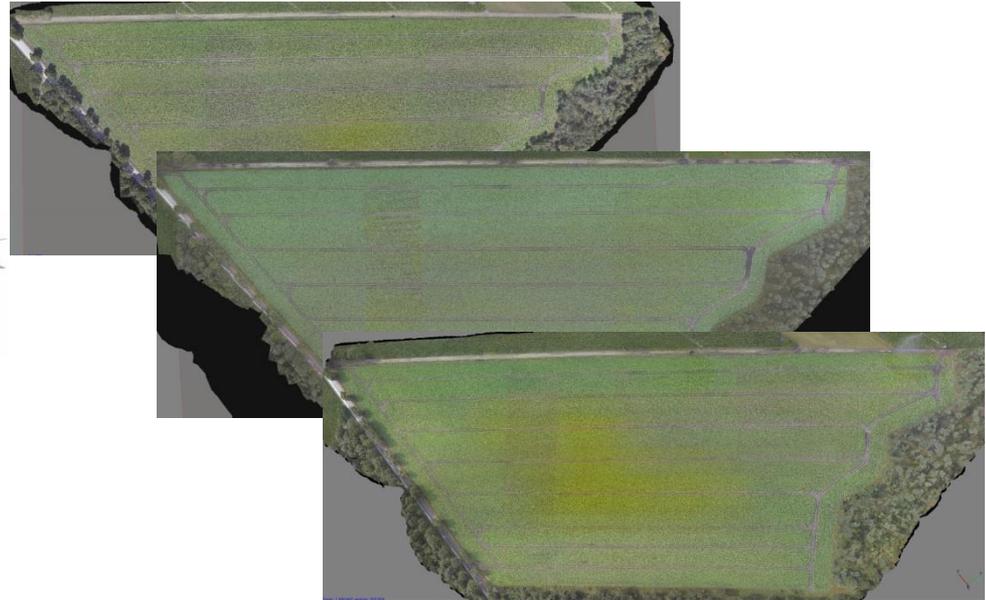
UAS mapping system:

- Combining with satellite data stream
- Automated flight path planning
- Onboard/cloud processing
- Communication with other platforms

Green: in control

Orange: attention required

Red: action required



Green Vision @ WUR

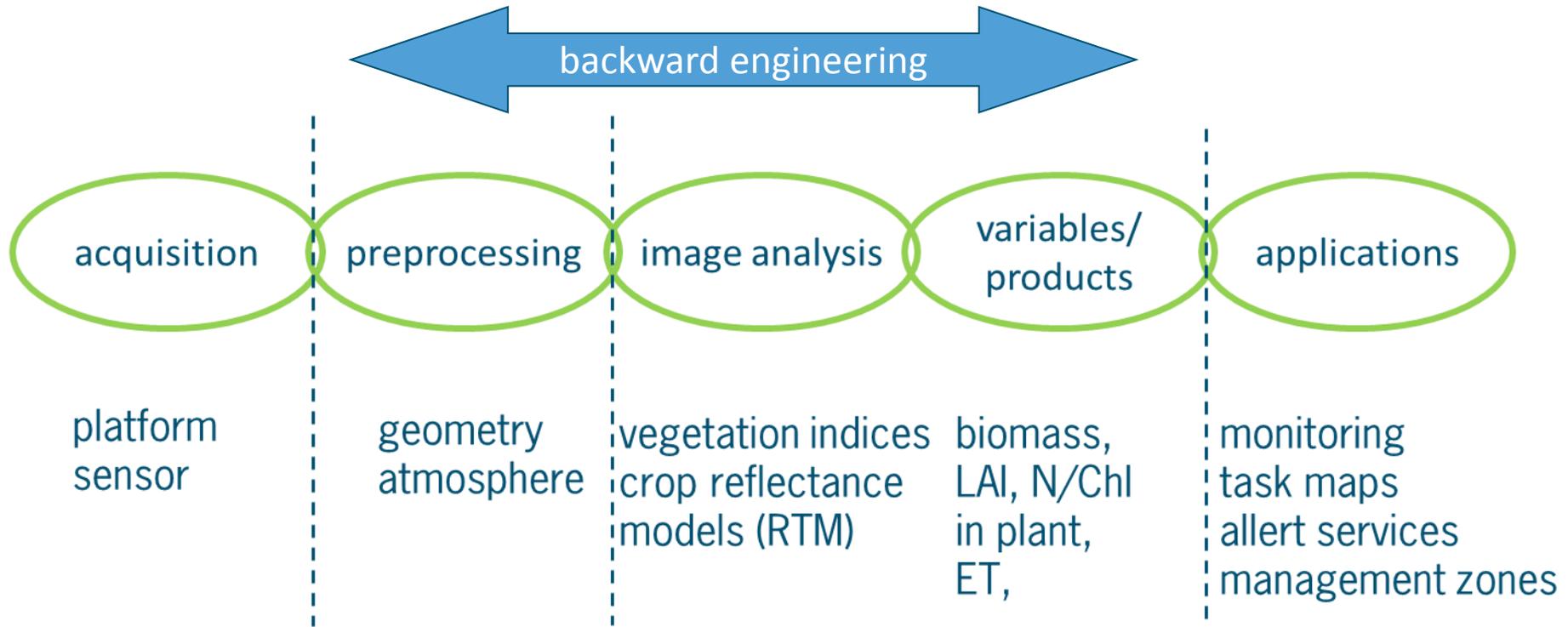


source: Economist

- <http://www.wageningenur.nl/nl/Onderzoek-Resultaten/Projecten/GreenVision.htm>
- Food & Biobased Research (FBR), Plant Research International (PRI) en Wageningen UR Glastuinbouw
- Agrofood Robotics and Machine Vision



Remote Sensing Science: UAS in a chain

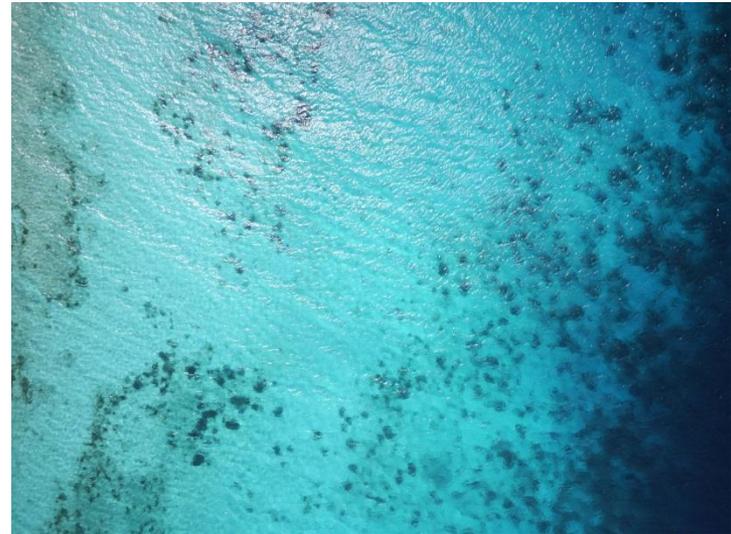
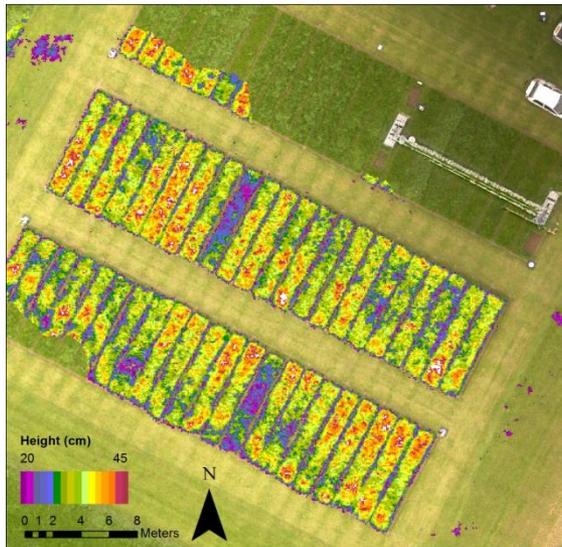


Outlook UAS as Smart Inspectors

- From mapping to monitoring
 - Consistent signal in time (spatially and spectrally)
 - Efficient processing chains -> real-time products
 - Innovative image processing techniques required: pixel based -> object based including point cloud
 - Integration with satellite and ground based sensors
- New UAS domains (for UARSF)
 - Forestry: canopy traits and forest structure (Suomalainen, Brede)
 - Camera systems: Thermal and lidar
 - Coastal management: Corjan Nolet and Marinka van Puijenbroek



Sensing a changing world



Acknowledgements



Van den Borne
Aardappelen



Thank you for your attention
www.wageningenur.nl/uarsf



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UAS in research and business: how to meet?

- Research <-> Commercial <-> End-users
 - Exchange/flow of knowledge
 - Sharing of protocols/best practices required
 - Sharing and exchange of facilities
 - regulatory frameworks
- Research Network Smart Inspectors (smartinspectors.net)

