Presented on behalf of the NZCPA by

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Massey University,
Palmerston North, New Zealand

Precision Agriculture - using Technology to Improve Water Use Efficiency (8256)

FIG Working Week 2016

CHRISTCHURCH, NEW ZEALAND 2–6 MAY 2016

Recovery from disaster

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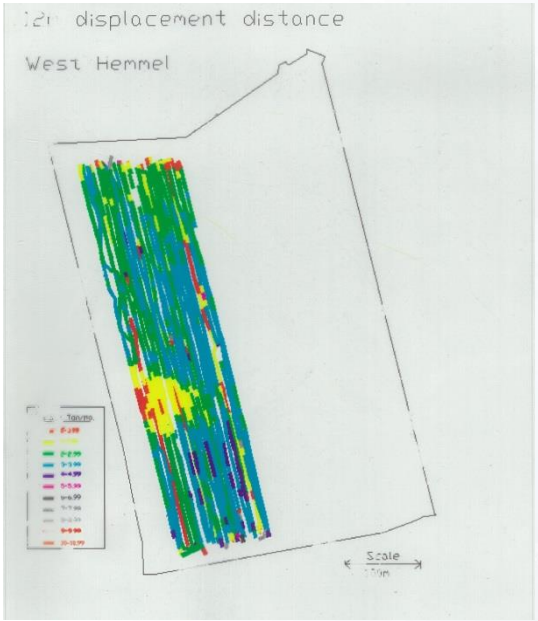
Precision Agriculture: using Technology to Improve Water Use Efficiency

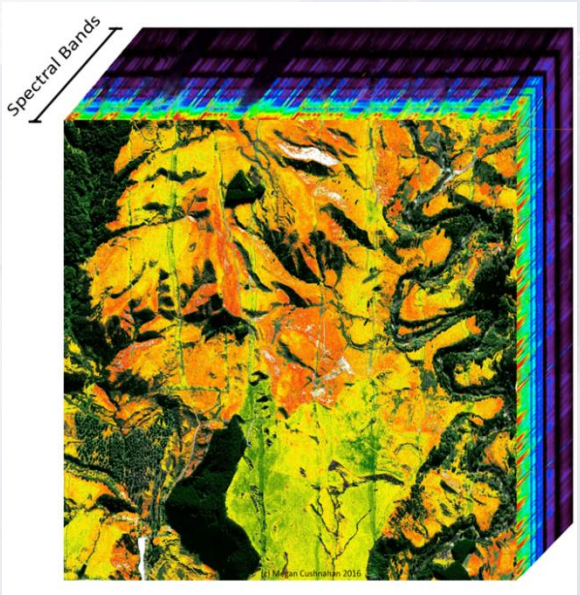
- A suite of measurement and control technologies based around the ability to spatially locate our actions.
- PA is now at an inflection point where the rules are rapidly changing and this has direct parallels with other industries. We are becoming data driven.
- This change is creating many challenges for us which will be common to the surveying industry. A lot of it revolves around managing end user expectations around data and data visualisation.

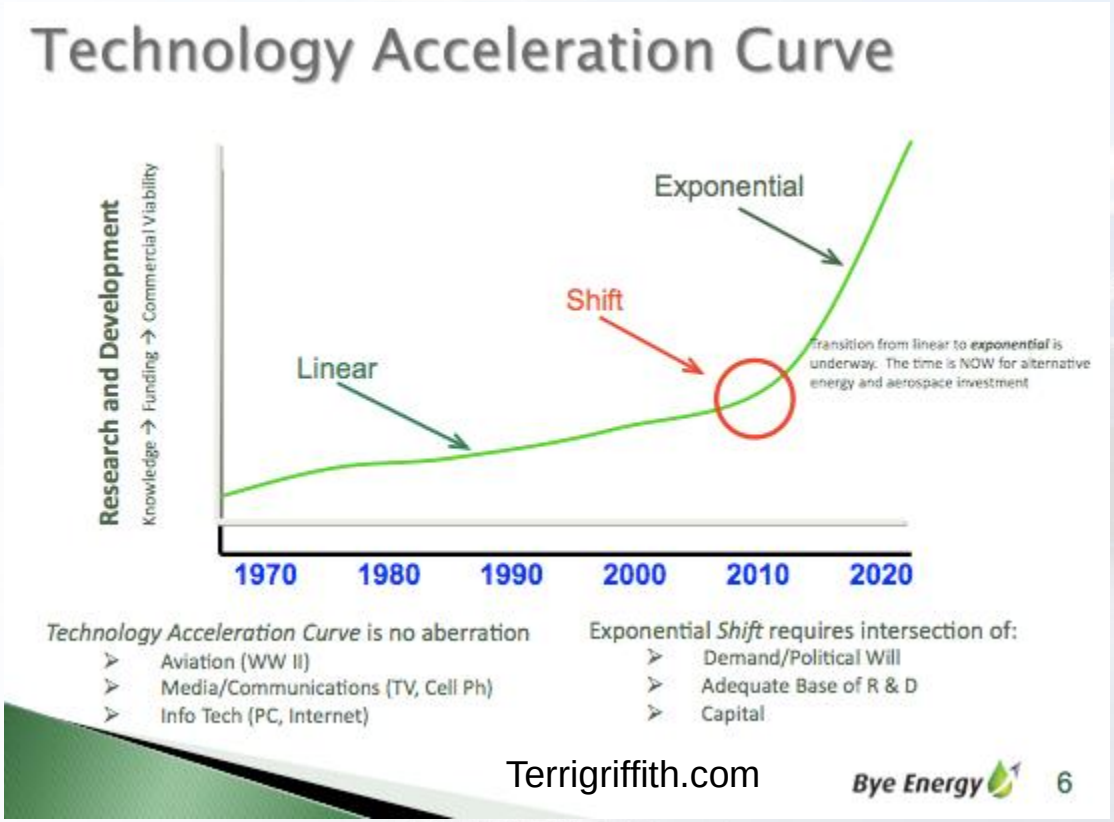
Precision Agriculture: Rapid development and increased sophistication.

First yield map I completed in 1991,
who can remember selective availability ?



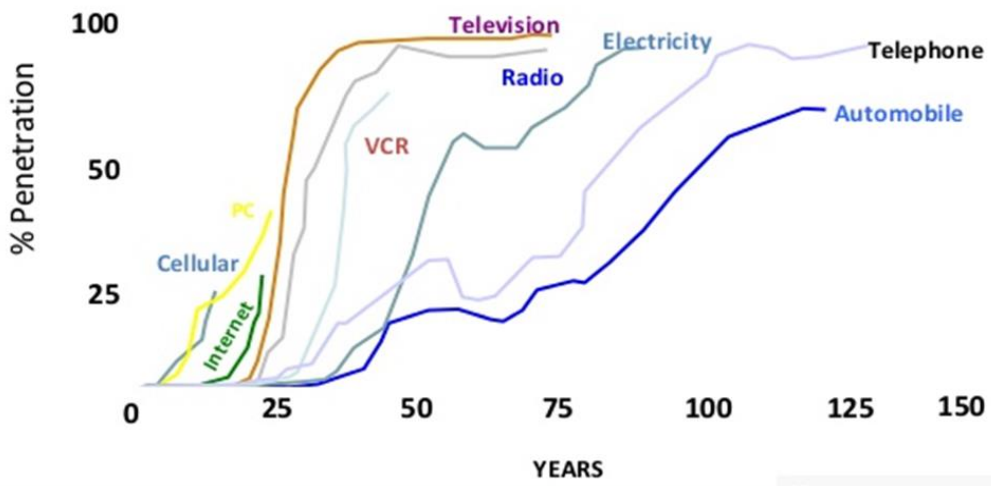
Hyperspectral imaging technology used 25 years later.




Technology Acceleration Curve
Research and Development
Knowledge → Funding → Commercial Viability
Exponential
Shift
Linear
Transition from linear to exponential is underway. The time is NOW for alternative energy and aerospace investment
1970
1980
1990
2000
2010
2020
Technology Acceleration Curve is no aberration
Aviation (WW II)
Media/Communications (TV, Cell Ph)
Info Tech (PC, Internet)
Exponential Shift requires intersection of:
Demand/Political Will
Adequate Base of R & D
Capital
Terrigriffith.com
Bye Energy
6

Innovation cycle times are being reduced.

Technological Acceleration



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IBM UPward (University Programs worldwide – accelerating regional development)

PA is at an inflection point.

- PA developed through spatial technologies, ability to locate and sense, then use that information to better control or inform operational management. Improved strategic management.
- That is what I would Term GEN 1.

- PA is now about data, and this is what I would term GEN 2.
- Multiple scale, multiple time, multiple source data, the internet of things etc.
- The speed and scale of the change seems to be escaping most people, we are not well equipped to deal with it.

Innovation Cycle: Rapid development. UAVs

Dramatically shortening: UAV's as an example of very rapid technical innovation.

- Got going 5 years ago, Craft have changed, usability has improved very rapidly, improving access.
- Commercial services now available for most industries. Kiwi fruit, forestry, viticulture, agriculture.
- Research organisations, maybe a couple up to play until recently but generally failing to keep up.
- Research organisations have had very little impact in the development of UAV services for NZ.

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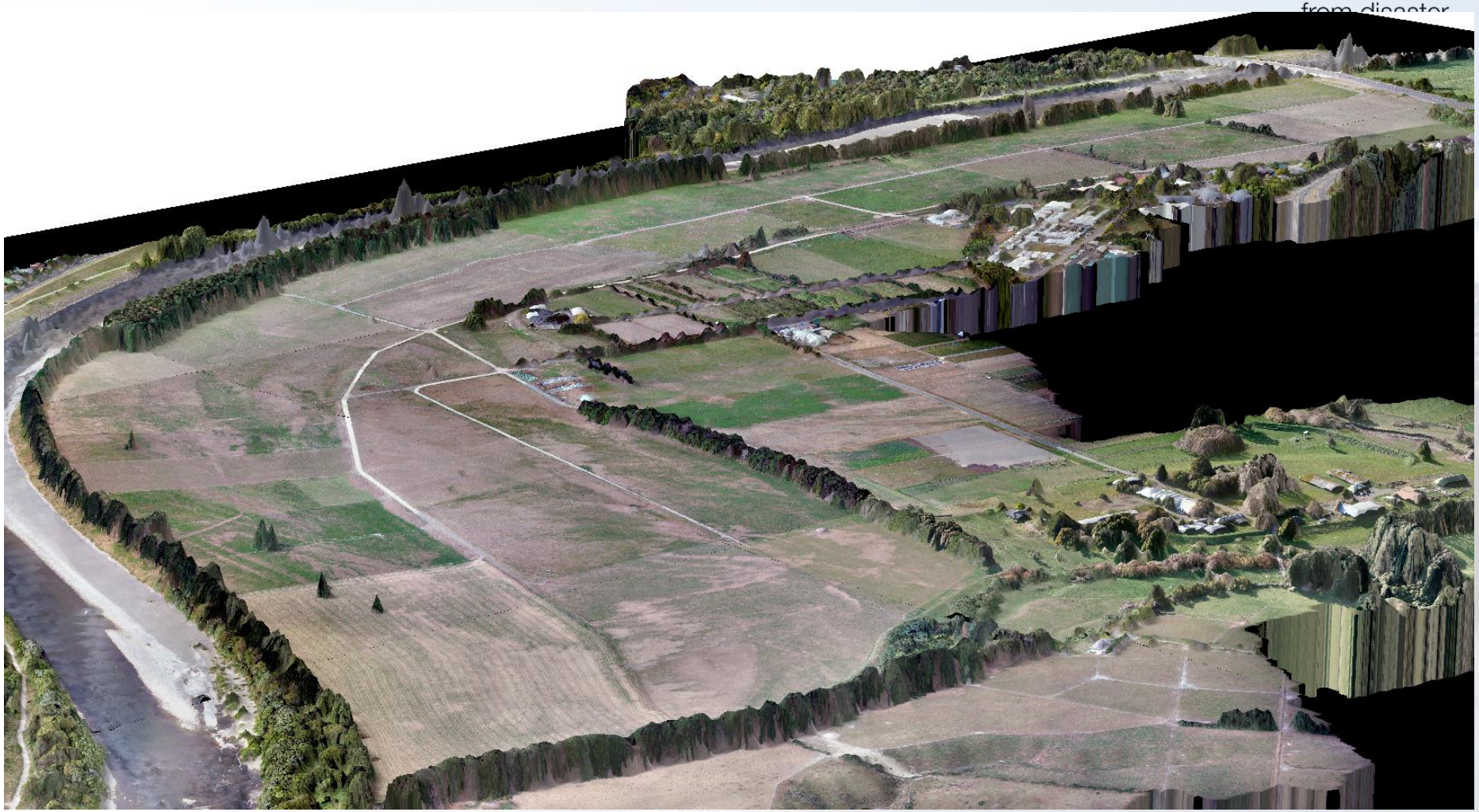
Recovery from disaster



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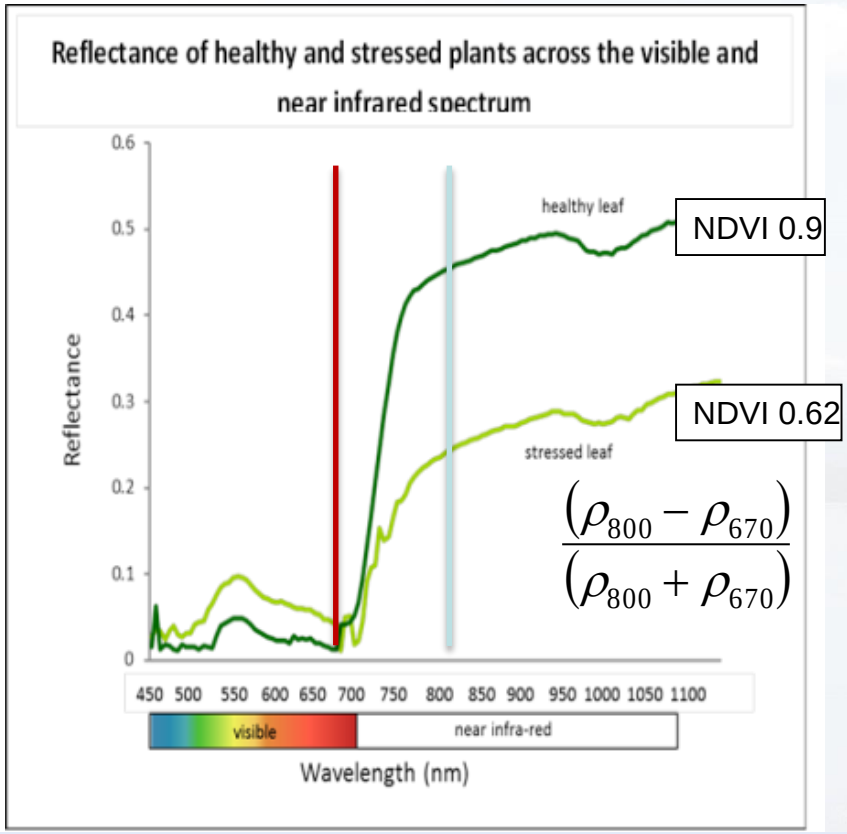
Applications of UAV Sensors Trimble UX5 System

Multispectral Sensing



A "typical" vegetation spectral signature changes with a number of biochemical and biophysical plant properties…

Biophysical properties such as growth stage, disease, plant density

Biochemical properties such as leaf nutrient concentrations

Atmospheric water, light angle and light intensity are a few of the factors that can vary the reflectance of a scene without any change from the target

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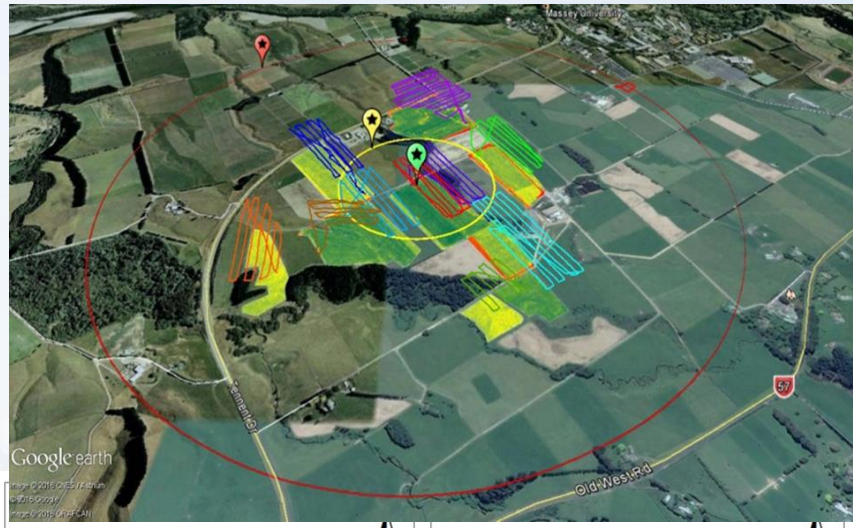
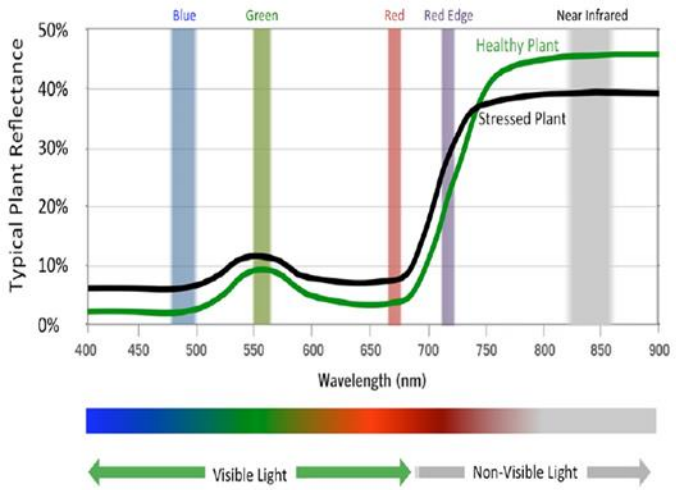
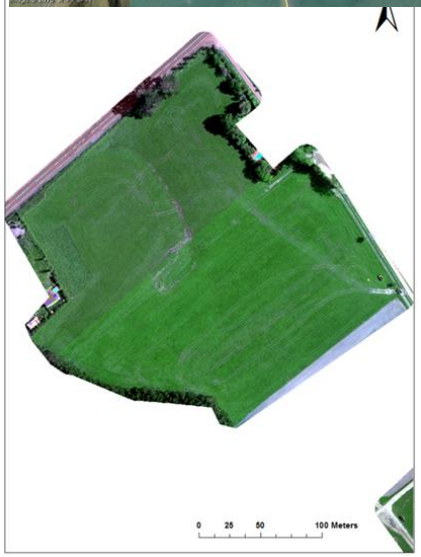
Recovery



Spectral bands

High-grade optical filters deliver precise information specially targeted to agricultural applications.





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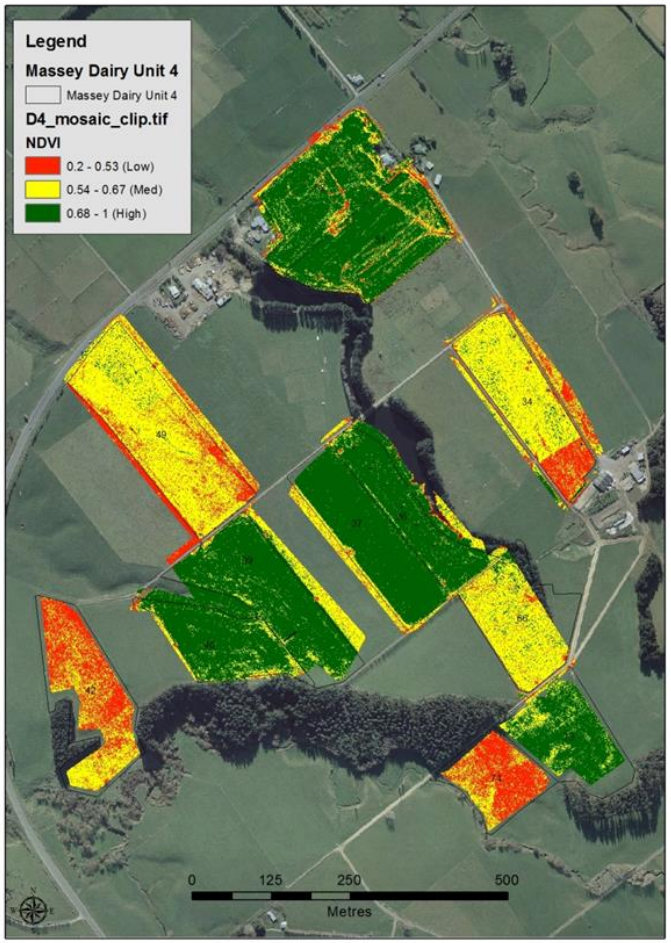
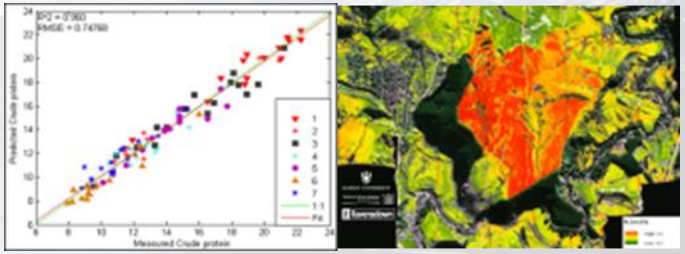
Massey Dairy 4

Massey Dairy 4

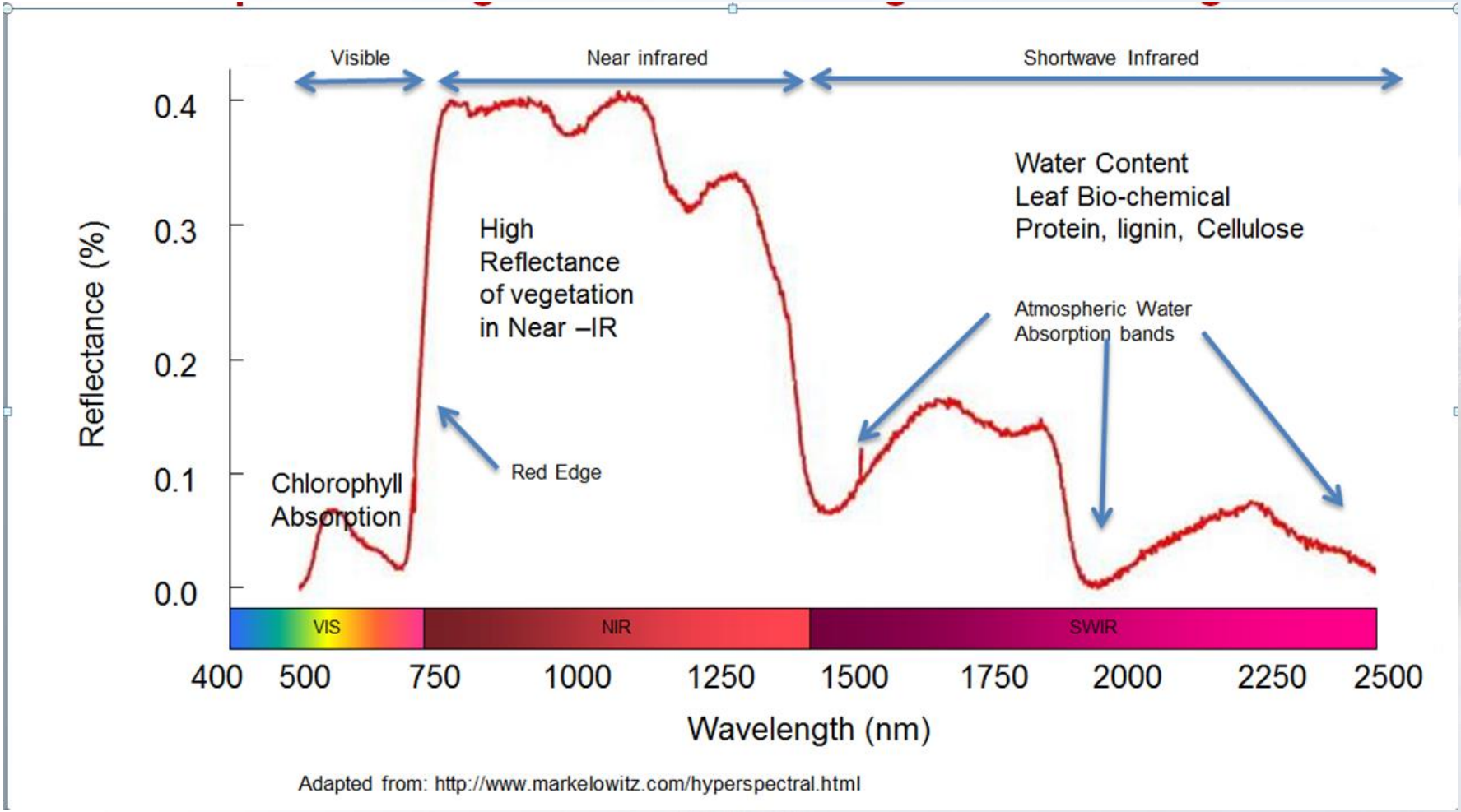


Hyperspectral Data

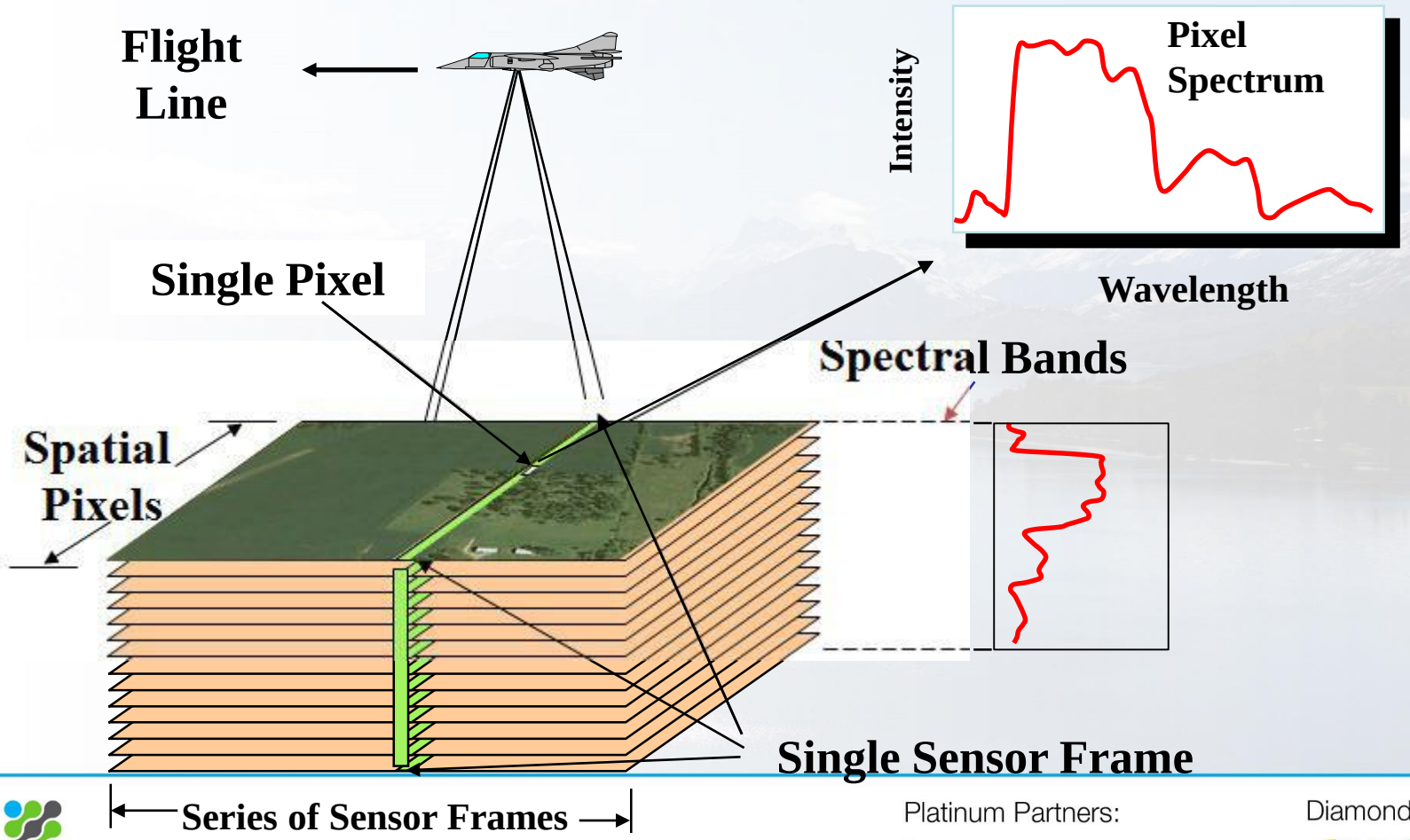
- Hyperspectral sensing and imaging has a long and proven track record in many fields.



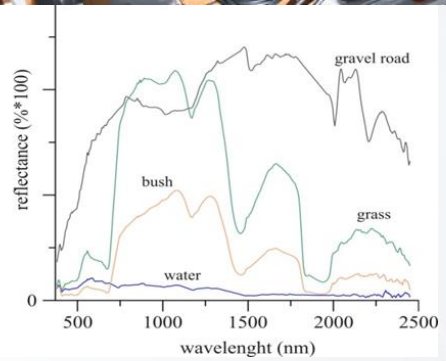
- This is no longer an experimental technology we are bringing it out of the laboratory to the real world.
- We had to progress from sensing to imaging.
- It is difficult to see the limits of where this can be applied.
- Further Applications: effective farming area, weed and disease management, horticulture, forestry (various applications), grazing management, animal health. Environmental management, identifying sustainable land management practices, nutrient attenuation. Crop and pasture, species - cultivar identification, plant health and moisture management, yield estimation, insurance loss adjustment. Erosion monitoring, land capability classification, hydrological modelling, etc etc.

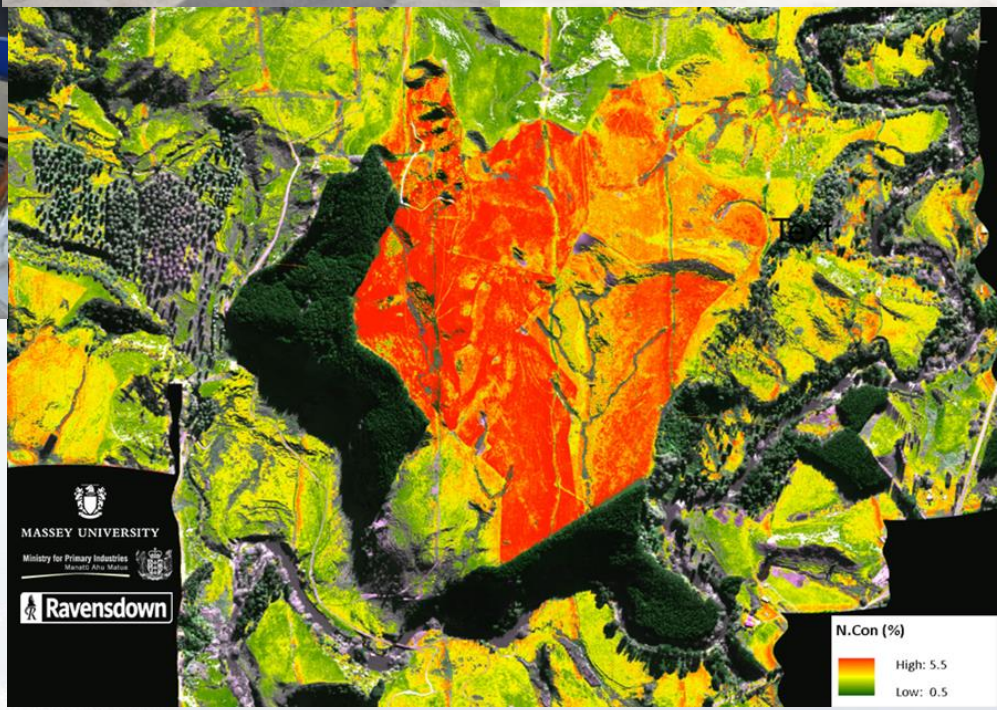

Visible
Near infrared
Shortwave Infrared
Reflectance (%)
0.4
0.3
0.2
0.1
0.0
High
Reflectance
of vegetation
in Near –IR
Water Content
Leaf Bio-chemical
Protein, lignin, Cellulose
Atmospheric Water
Absorption bands
Red Edge
Chlorophyll
Absorption
VIS
NIR
SWIR
400
500
750
1000
1250
1500
1750
2000
2250
2500
Wavelength (nm)
Adapted from: http://www.markelowitz.com/hyperspectral.html

Push-broom hyperspectral imaging



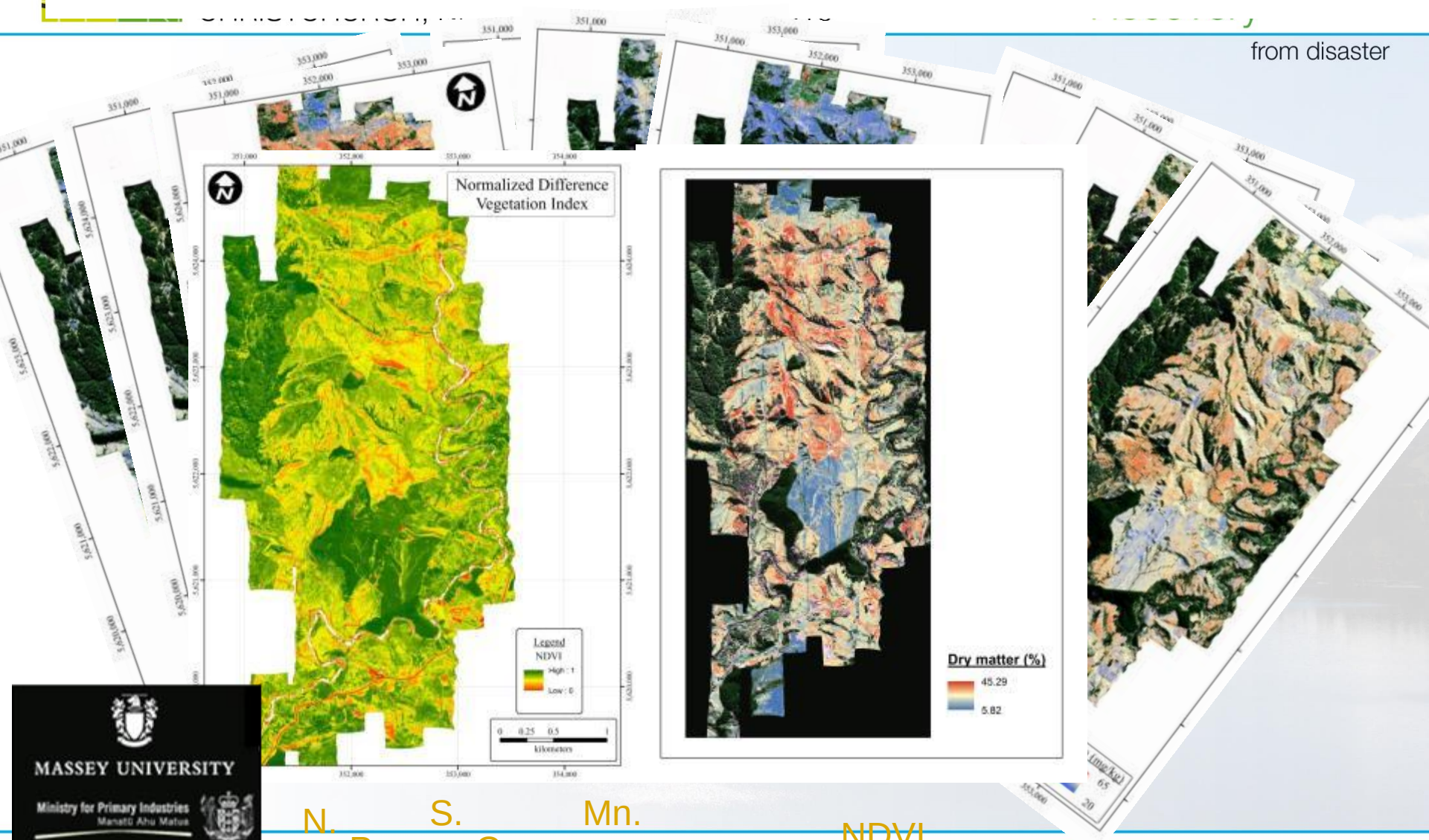
Hyperspectral Imaging: Fenix Airborne Sensor





We can now describe our environment in a lot of detail

from disaster



N. S. Mn. NDVI

P. Cu. Na.

K. Mg. Zn. Dry Matter

MASSEY UNIVERSITY

Ministry for Primary Industries
Manatū Ahu Matua

Ravensdown

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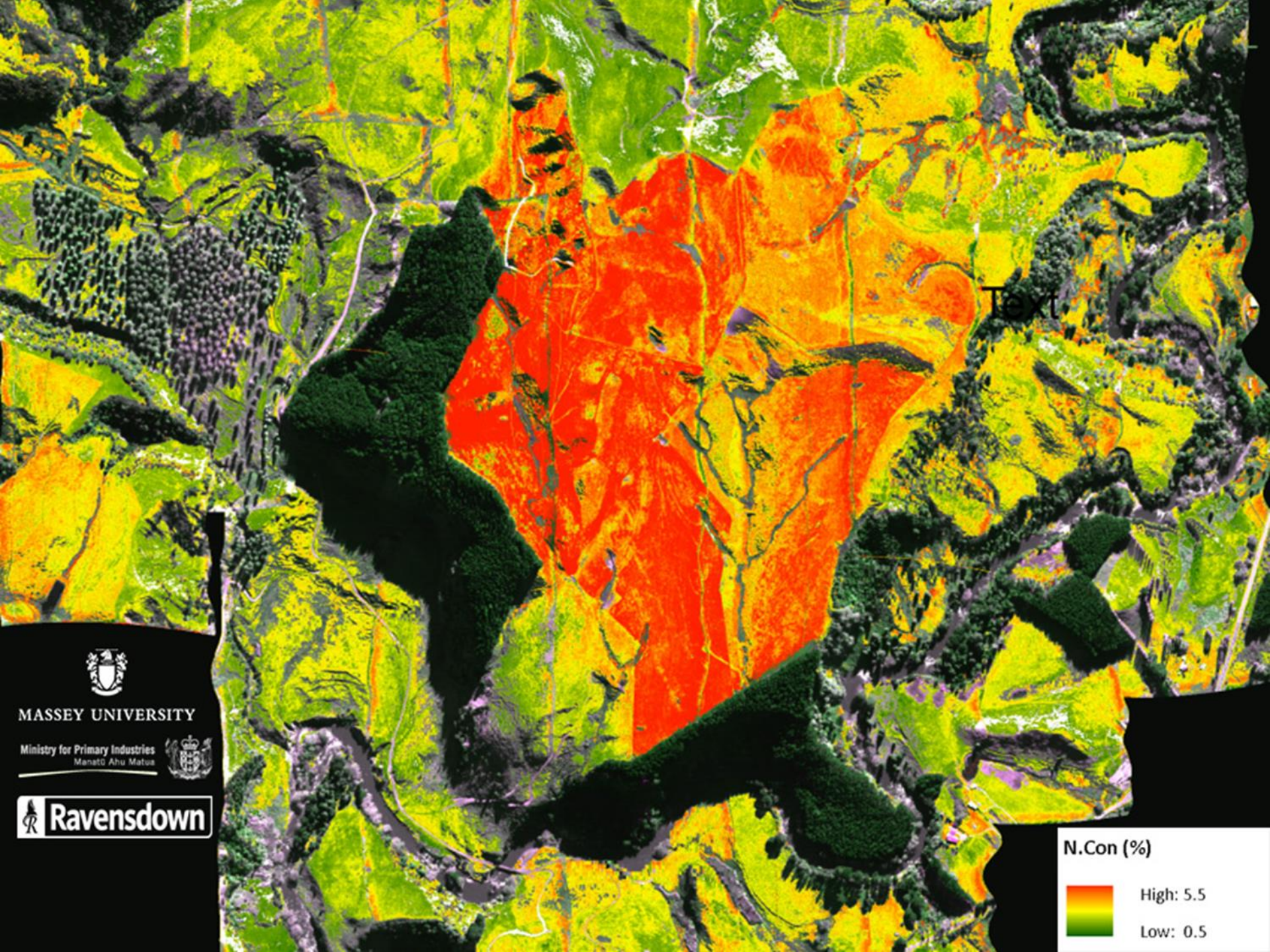
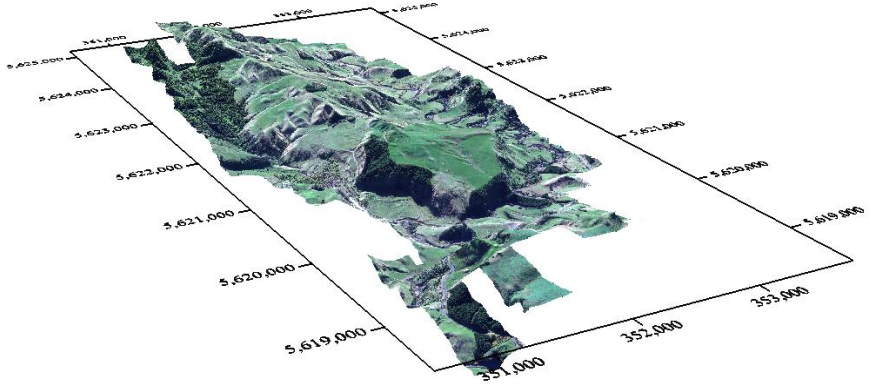
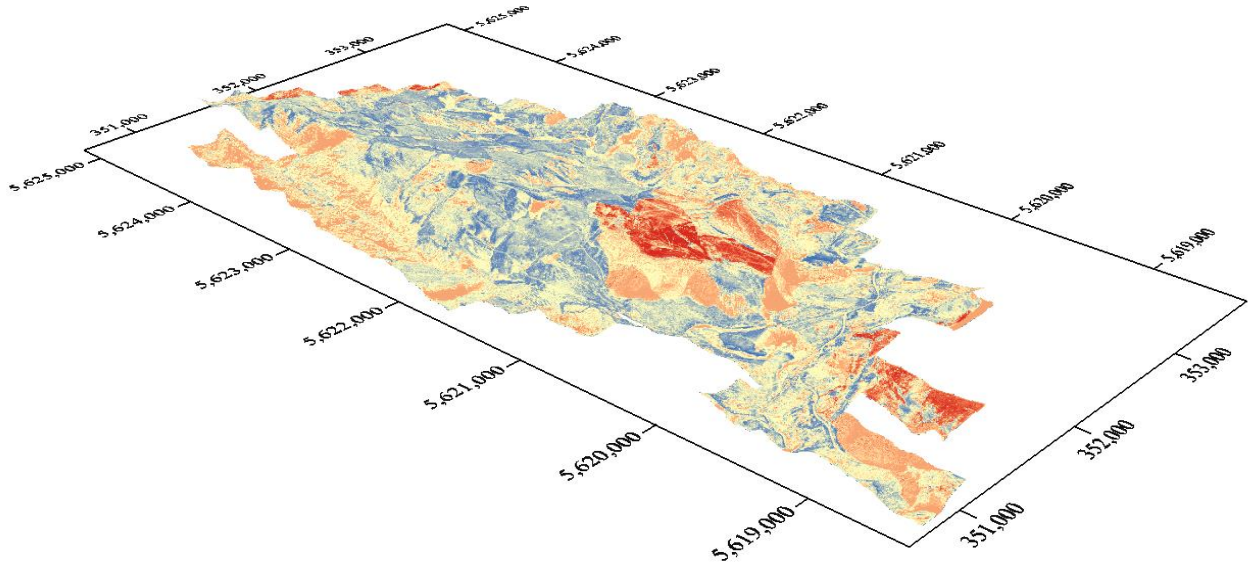

MASSEY UNIVERSITY
Ministry for Primary Industries
Manatū Ahu Matua
Ravensdown
N.Con (%)
High: 5.5
Low: 0.5

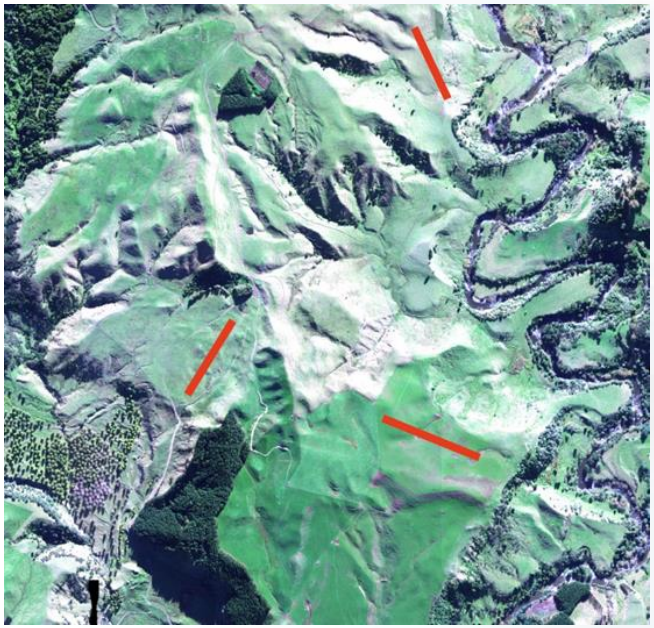
RGB Visualisation of farm



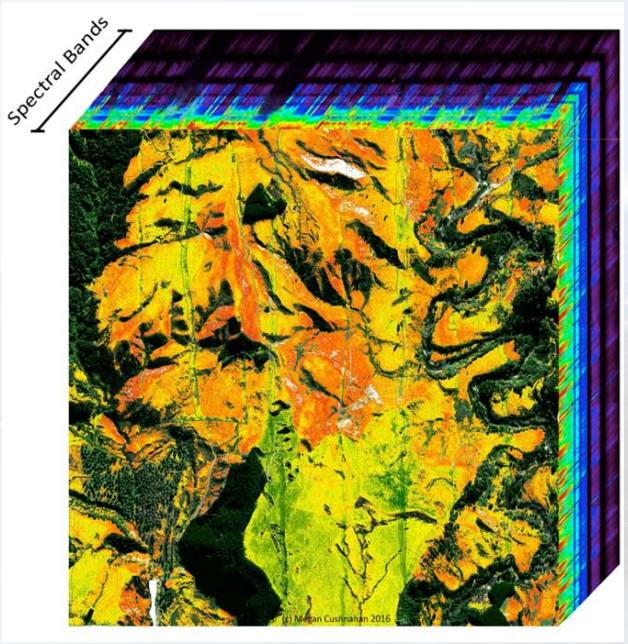
Nitrogen concentration in pasture



The new data economy

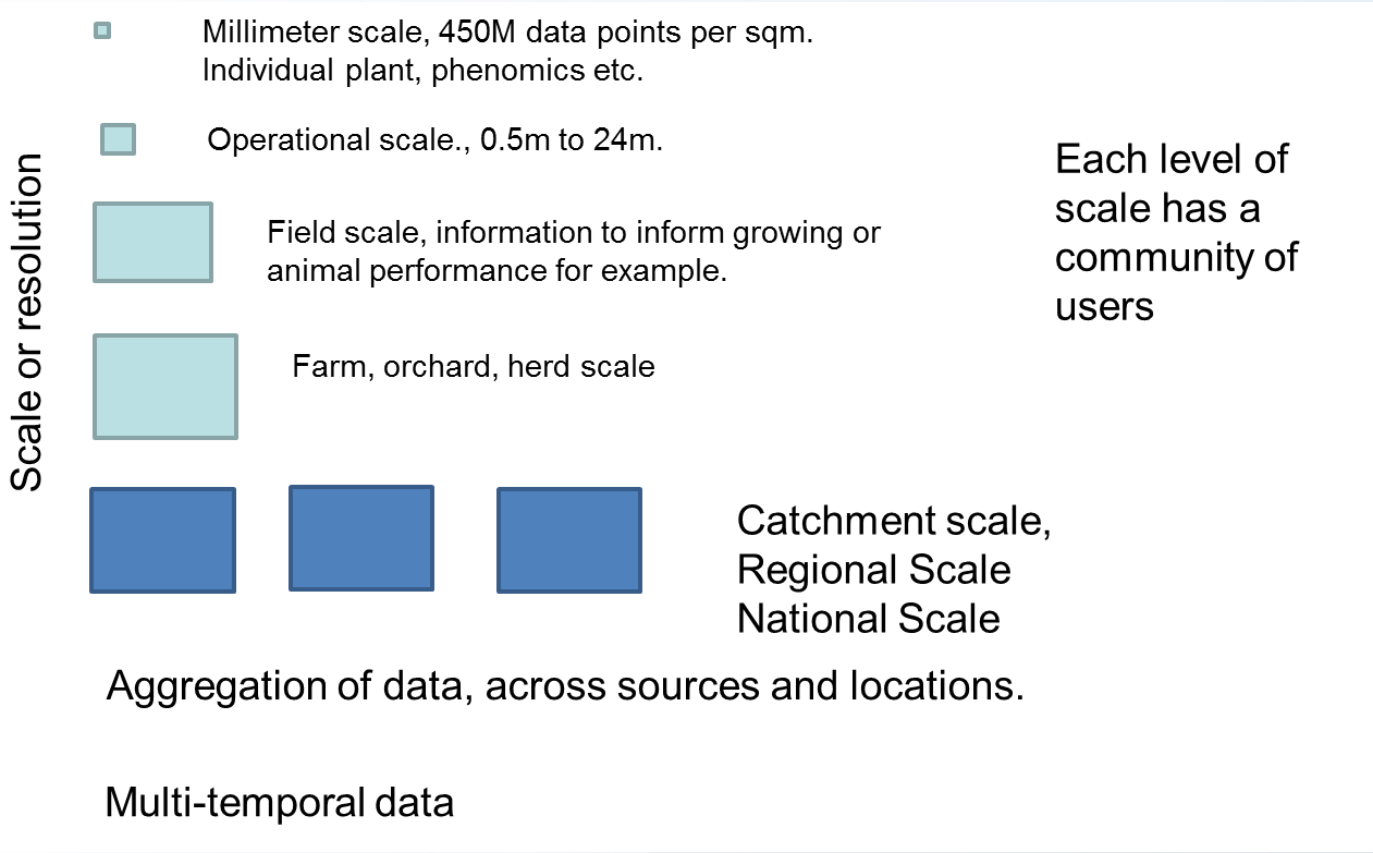


3 transects samples per 3,000ha (and then interpolate observations in terms of previous rules, how robust?)



4,500,000 data points per ha. (4.5M)
13,500,000,000 data points per 3000 ha farm.

Speed and Scale of Change



Data Fear

- A lot of negative terms being applied to data:
- Data lakes,
  - Fear of drowning
- Data Graveyard,
  - Fear of death,
- Data redundancy,
  - Used to old model where data was expensive.

Big Data: Wrong term, does not convey the level and scale of change.

Digital Agriculture, Horticulture, Forestry, Viticulture

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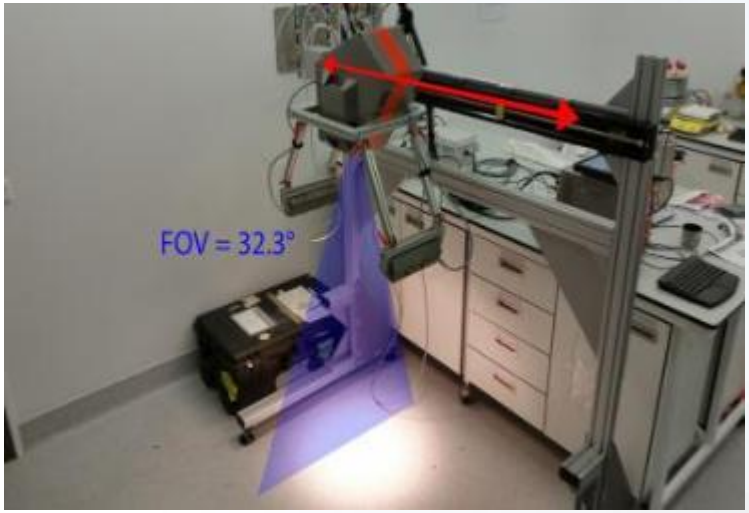


Ground based imaging

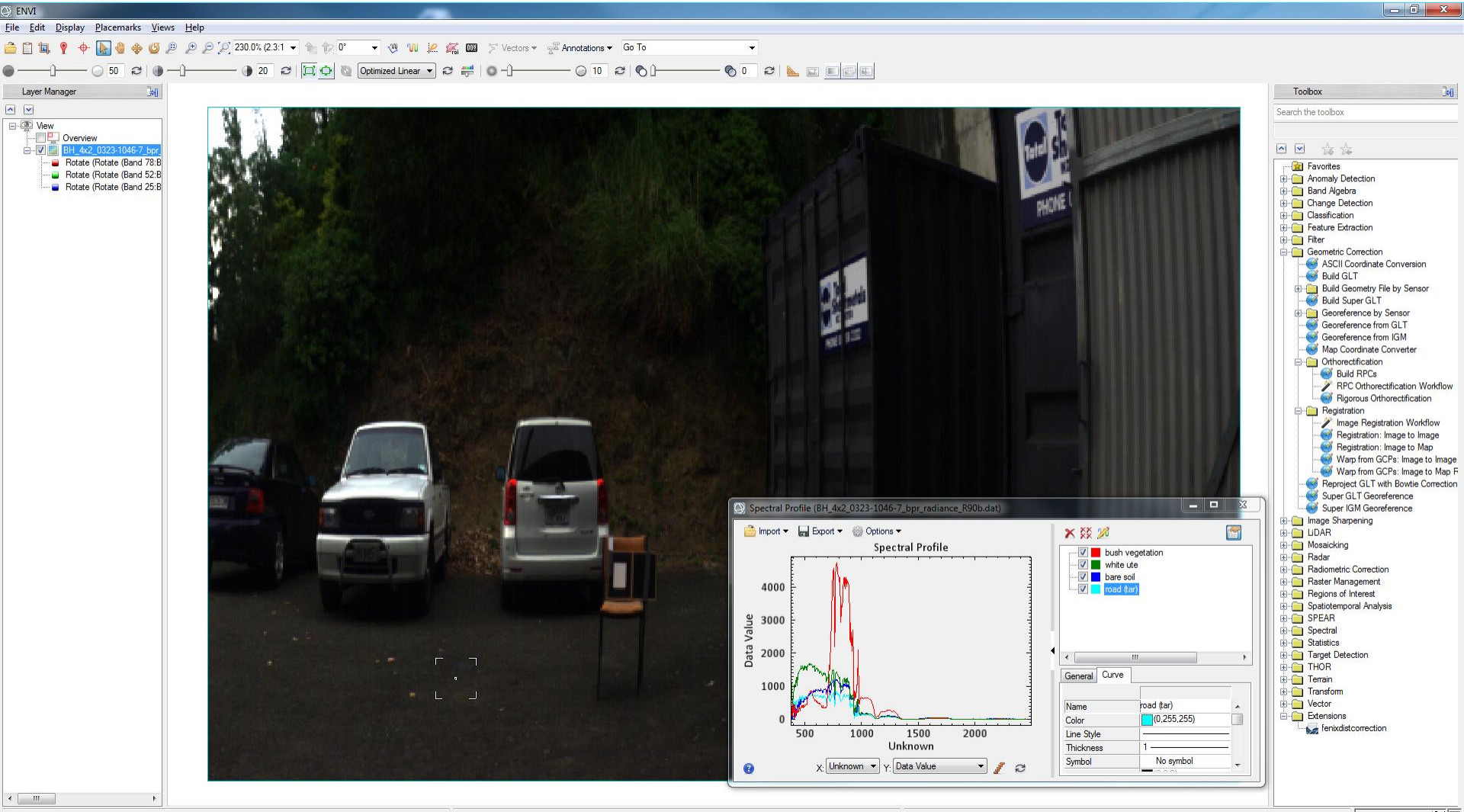
The same Fenix imaging system can be used close up to scan an object producing a detailed hyperspectral image of that object. Spatial resolution just over 1 mm. 1 Million points per m^2

High speed imaging, takes two minutes to complete a scan.

Rotary stage, allows the Fenix to rotate and take an image of a vista.

Closer view than aerial, flexibility, possible to mount on a mobile robot actuator for example.

This opens up all sorts of inspection opportunities for biosecurity purposes for example.


ENVI
File Edit Display Placemarks Views Help
Layer Manager
View
Overview
BH_4x2_0323-1046-7_bpr
Rotate (Rotate (Band 78:B
Rotate (Rotate (Band 52:B
Rotate (Rotate (Band 25:B
Toolbox
Search the toolbox
Favorites
Anomaly Detection
Band Algebra
Change Detection
Classification
Feature Extraction
Filter
Geometric Correction
ASCII Coordinate Conversion
Build GLT
Build Geometry File by Sensor
Build Super GLT
Georeference by Sensor
Georeference from GLT
Georeference from IGM
Map Coordinate Converter
Orthorectification
Build RPCs
RPC Orthorectification Workflow
Rigorous Orthorectification
Registration
Image Registration Workflow
Registration: Image to Image
Registration: Image to Map
Warp from GCPs: Image to Image
Warp from GCPs: Image to Map
Reproject GLT with Bowtie Correction
Super GLT Georeference
Super IGM Georeference
Image Sharpening
LiDAR
Mosaicking
Radar
Radiometric Correction
Raster Management
Regions of Interest
Spatiotemporal Analysis
SPEAR
Spectral
Statistics
Target Detection
THOR
Terrain
Transform
Vector
Extensions
fenixdistcorrection
Spectral Profile (BH_4x2_0323-1046-7_bpr_radiance_R90b.dat)
Import Export Options
Spectral Profile
Data Value
Unknown
bush vegetation
white ute
bare soil
road (tar)
General Curve
Name
Color
Line Style
Thickness
Symbol
No symbol

Conclusions

- Managing water is an important element in our precision agriculture.
- Sensing and imaging are making huge strides in terms of describing our environment.
- Data is growing at an exponential rate.
- How do you turn data into information.
- Visualisation of data is an extremely important element.
- Even hyperspectral imaging is becoming more accessible and can be used from multiple platforms.