AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY

The Irish Agriculture and Food Development Authority

REDP

Watching Grass Grow: Irish Land Monitoring Observatory

Stuart Green

Teagasc Rural Economy and Development Programme (REDP)

UCD

10th July 2013

PI: Cawkwell, F., Dwyer, N.,Nitze, I., Barrett, B.-UCC
Kevin Black, FERS Ltd
OSI

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Agriculture and Food Development Authority

The Irish Agriculture and Food Development Authority

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REDP

The national body providing integrated research, advisory and training services to agriculture and the food industry.
www.teagasc.ie

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Irish Land Mapping Observatory-**ILMO**

"..develop an integrated geoinformatics approach to detecting land cover, cover, use and management within Irish agricultural grass lands, as well as well as monitoring changes on an inter and intra-annual basis"

ILMO is an Environmental Protection Agency (EPA) funded project (2011-CCRP-MS1.4). All SAR data have been been provided by the European Space Agency (ESA) under Cat-1 project ID 11768

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Why Grass?

- Most Important Natural resource in the county- the Emerald Isle.
- Supports Directly 100,000 farmers and a 6 Billion Euro Export Export Industry.
- Grassland Farms are the main component of the Irish Landscape-important part of the tourism “package”.
- Grassland is an important element of Biodiversity.
- Grass management a key to farm productivity: Teagasc research has shown that by extending the grazing season by by only 2 weeks- the average dairy farm can reduce costs by by 2000 euro pa.

Policy Drivers

- Climate Change- LULUC reporting.
- Food security.
- Harvest 2020.

- No national Landcover map-real Data need.

What does the project do?

- In short we “fill” predefined field boundaries with labels on grass type- derived from RADAR data.
- We label the fields with Grassland use derived from from hyper temporal optical data.
- We monitor the grassland, in terms of accumulated accumulated biomass (DM kg/ha/day) using optical data to measure output and, in conjunction with weather data, management options.

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3 Parts

- Mapping Grassland Types
- Monitoring Grassland Change/Management
- Measuring Grass Growth

OSI:Prime 2- the field Objects

- One of the reasons for the success of the project is access to the OSI Prime2 mapping data.
- Akin to the UK Master Map, it's a seamless map of geographical geographical objects.
- Allows us to segment our classification with real objects
- We can characterise and label every field using all of the RS data, leaving the OSI P2 data to do the work of demarcation.

Level 0	Level 1	L2	L3	L4
Grassland	Improved Grassland [GA]	DRY [GAd]		Grazing [GAdg]
				Cutting [GADc]
		Reclaimed [GAr]		Grazing [GAgg]
	Semi-Improved Grassland [GS]	Wet [GSw]		Reverting [GSwr]
				Grazing [GSwg]
		Dry [GSd]	Humic [GSdh]	Reverting [GSdhr]
				Grazing [GSdhg]
			Calcareous [GSdc]	Reverting [GSdcr]
				Grazing [GSdcg]
Forest land Settlement Water, Peatland,Cropland	Not Grassland [NA]			

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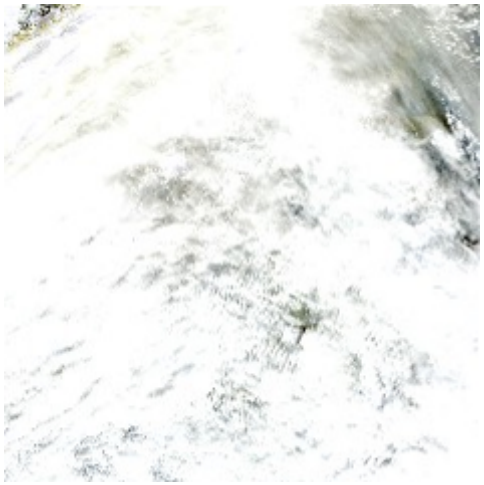
Ireland and optical Remote Sensing – a very *special*

MODIS Terra 26/05/2012
26/05/2012

MODIS Terra 12/05/2012
12/05/2012



MODIS Terra 24/01/2012
24/01/2012

Clouds of all kinds interfere with the “true” signal
General atmospheric disturbances
Bi-directional reflectance

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RADAR-Brian Barret

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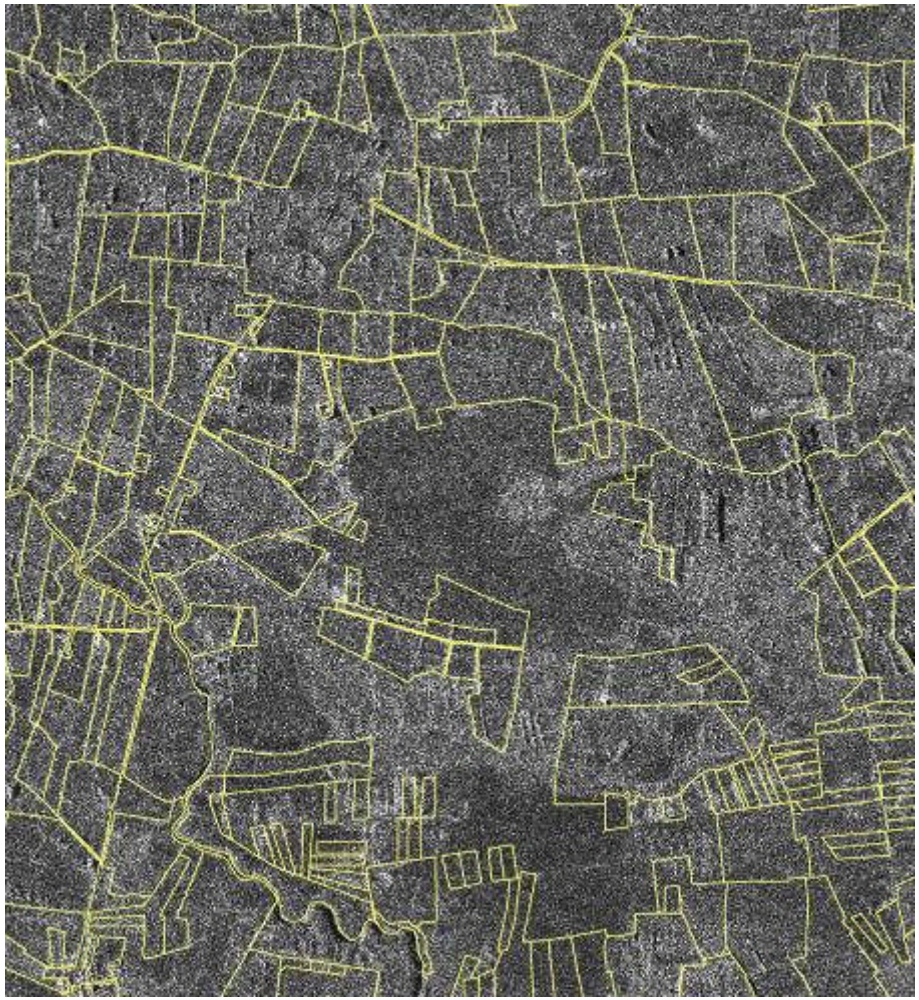
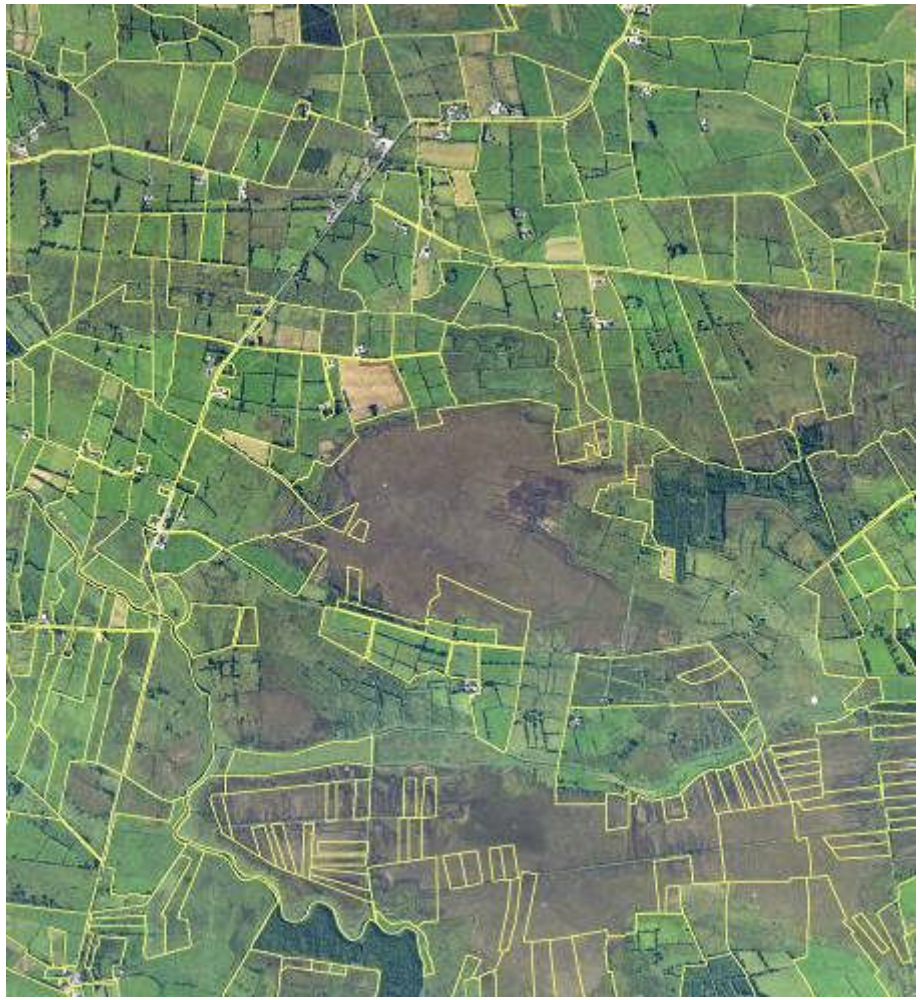
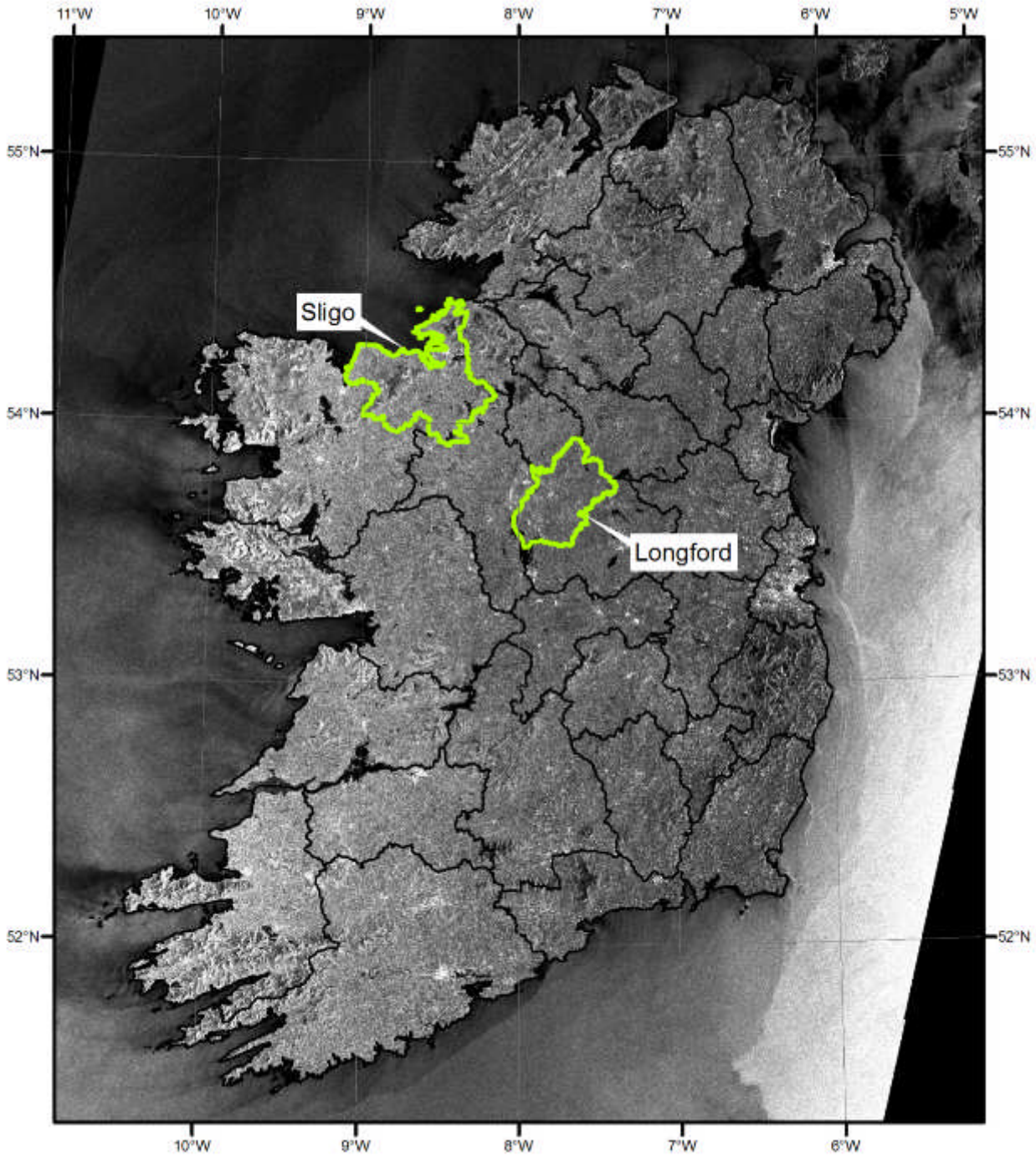
Grass Types with : RADAR







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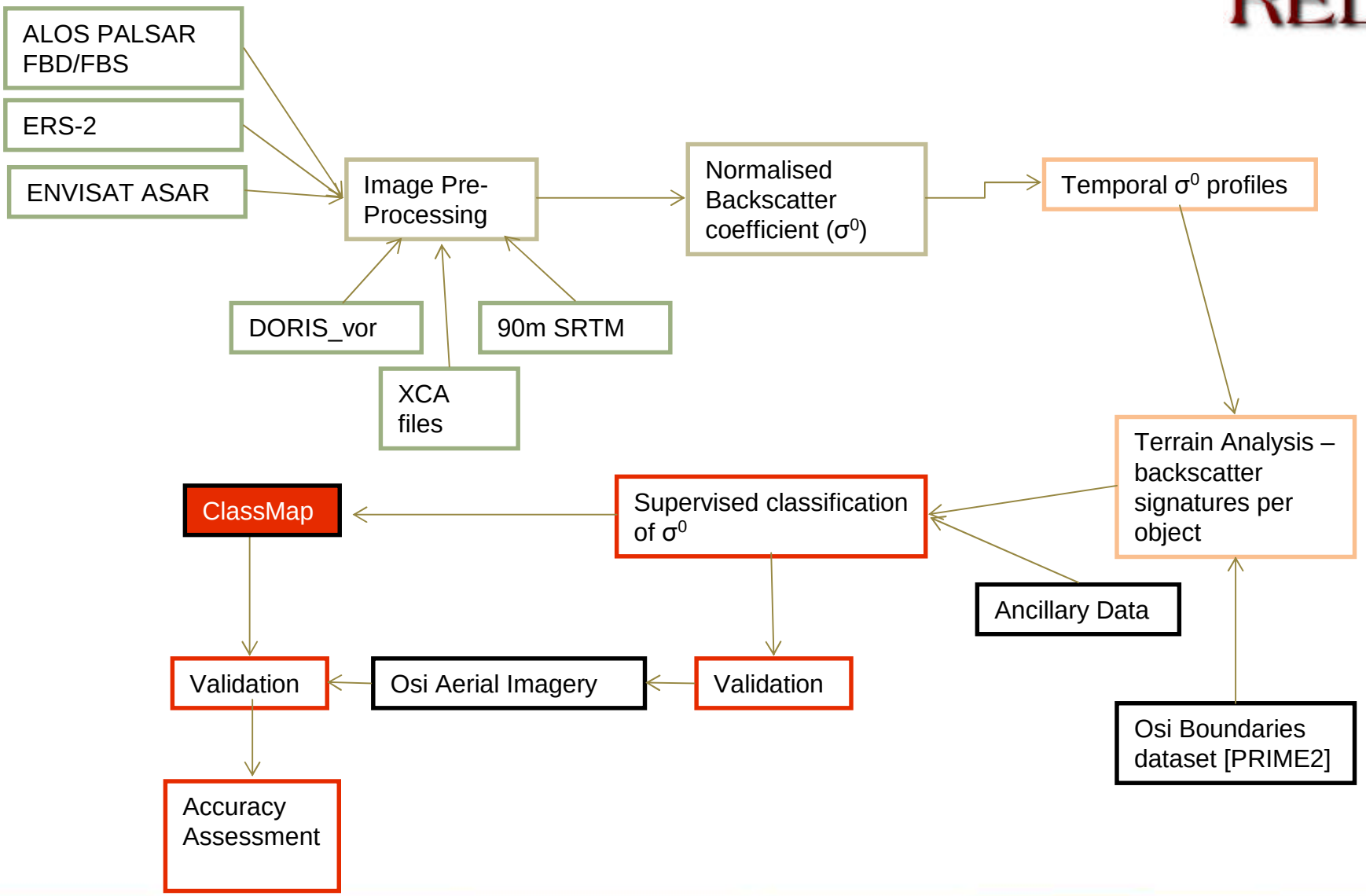
ALOS PALSAR FBD/FBS
ERS-2
ENVISAT ASAR
Image Pre-Processing
Normalised Backscatter coefficient (σ^0)
Temporal σ^0 profiles
DORIS_vor
90m SRTM
XCA files
Terrain Analysis – backscatter signatures per object
ClassMap
Supervised classification of σ^0
Ancillary Data
Validation
Osi Aerial Imagery
Validation
Osi Boundaries dataset [PRIME2]
Accuracy Assessment

TABLE 2: RESULTS OF DIFFERENT CLASSIFICATIONS FOR SLIGO [LEVEL 3 INCLUSIVE] (RF=Random Forest, SVM=Support Vector Machine, PA=Producer's Accuracy, UA=User's Accuracy)

Class	clband_so				clbandv2_so				clbandv3_so				clbandv4_so			
	RF		SVM		RF		SVM		RF		SVM		RF		SVM	
	PA	UA	PA	UA	PA	UA	PA	UA	PA	UA	PA	UA	PA	UA	PA	UA
Forests	0.99	0.99	0.98	0.99	0.99	1.00	0.99	0.98	0.99	0.99	0.99	0.98	0.99	0.99	0.99	0.99
Water	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Settlement	0.98	0.98	0.99	0.97	0.98	0.98	0.95	0.99	0.98	0.98	0.94	0.98	0.99	0.99	0.99	0.99
Peatland	0.94	0.99	0.95	0.99	0.95	0.99	0.99	0.99	0.95	0.99	0.98	0.99	0.96	0.99	0.99	0.99
Cropland	0.99	0.93	0.98	0.95	0.99	0.95	1.00	0.96	0.99	0.93	0.99	0.95	0.99	0.96	0.99	1.00
GSdh	0.87	0.61	0.80	0.64	0.87	0.63	0.79	0.79	0.84	0.59	0.78	0.78	0.84	0.65	0.77	0.80
GSdc	0.77	0.50	0.60	0.49	0.80	0.54	0.81	0.74	0.76	0.52	0.80	0.74	0.79	0.57	0.79	0.79
GAd	0.80	0.94	0.81	0.89	0.81	0.93	0.87	0.92	0.81	0.93	0.87	0.92	0.83	0.93	0.89	0.89
GAr	0.86	0.78	0.76	0.79	0.86	0.79	0.88	0.86	0.86	0.81	0.88	0.86	0.86	0.82	0.89	0.87
GSw	0.76	0.75	0.70	0.65	0.77	0.77	0.88	0.83	0.76	0.76	0.87	0.82	0.78	0.77	0.86	0.85
Overall Accuracy	89.8%		87.9%		90.4%		92.8%		90.2%		92.5%		90.9%		93.3%	
Kappa coefficient	0.88		0.86		0.89		0.92		0.89		0.91		0.90		0.92	

*GSdh = humic semi-improved dry grassland, GSdc = calcareous semi-improved dry grassland, GAd = dry improved grassland, GAr = reclaimed improved grassland, GSw = wet semi-improved grassland

Pixel-level Prediction Probability [Sligo]

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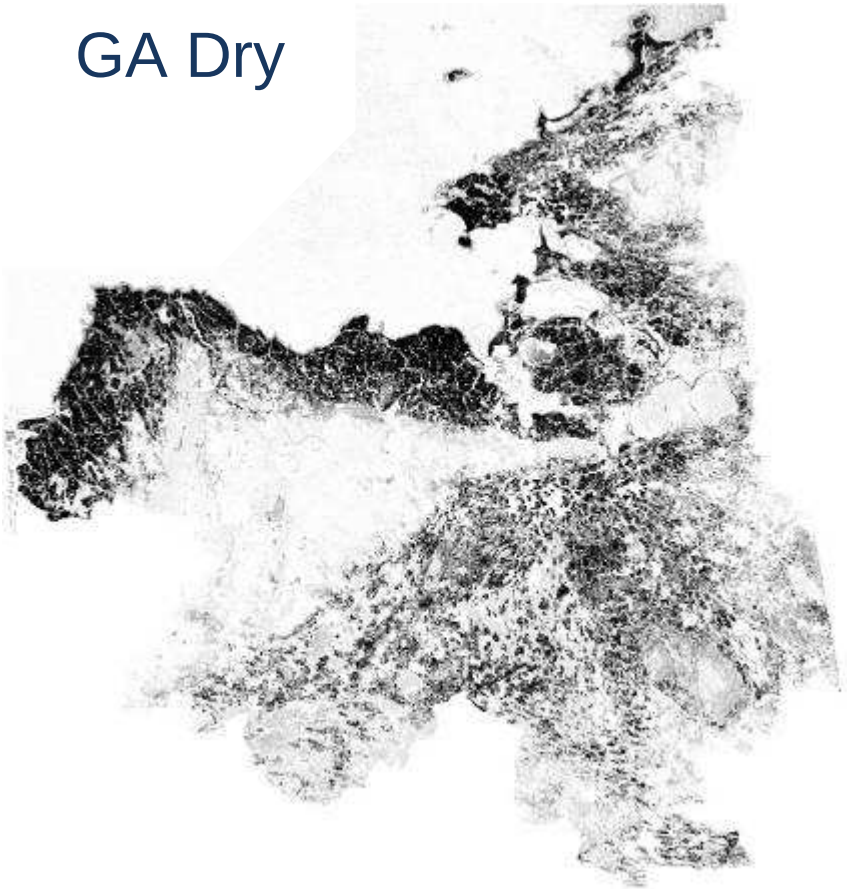
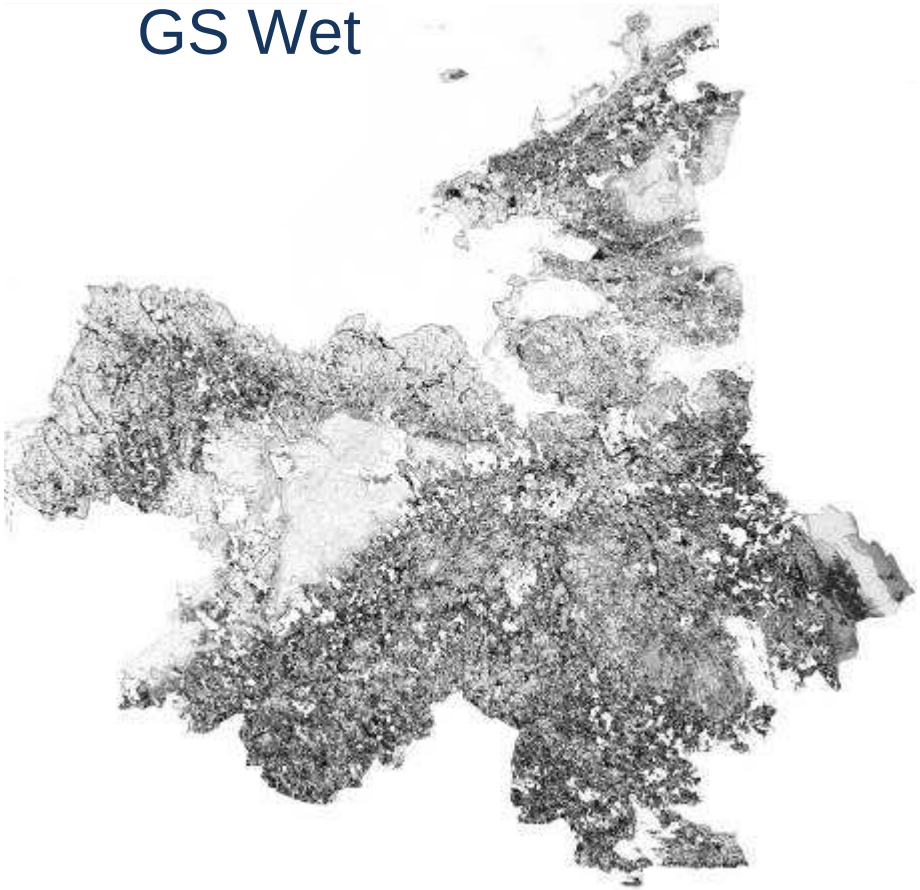
GA Dry



GS Wet



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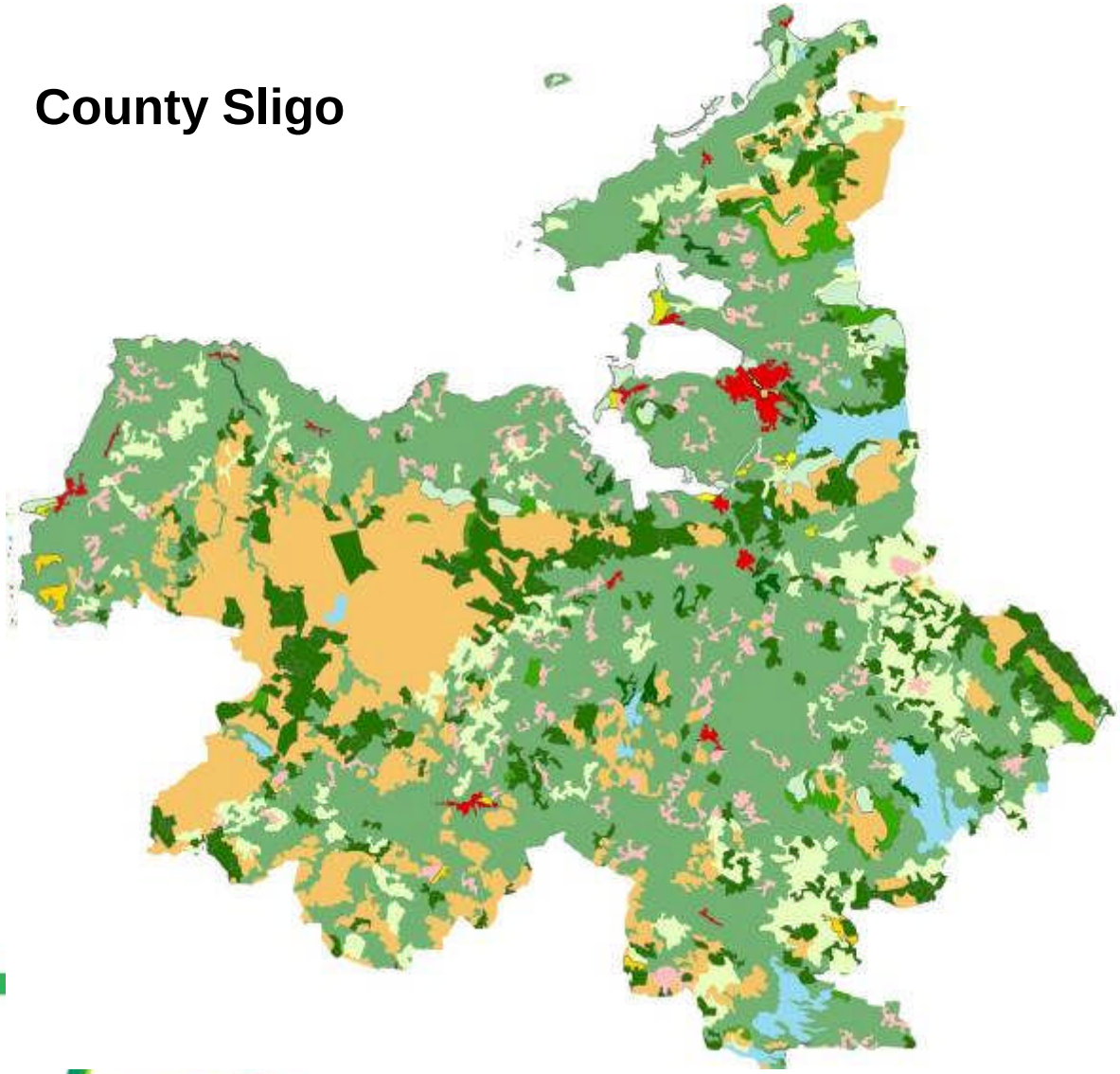
County Sligo



Radar Classification Map

Prime2 Radar Map [raster]

CORINE 2006

- Forest
- Water
- Settlement
- Peatland
- Crop
- GSd humic
- GSd calcareous
- GA Dry
- GA Reclaimed
- GS Wet

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OPTICAL- Ingmar Nitze

Grass Use with Optical Data

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Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Increasing Biomass

Optical: MODIS Time Series

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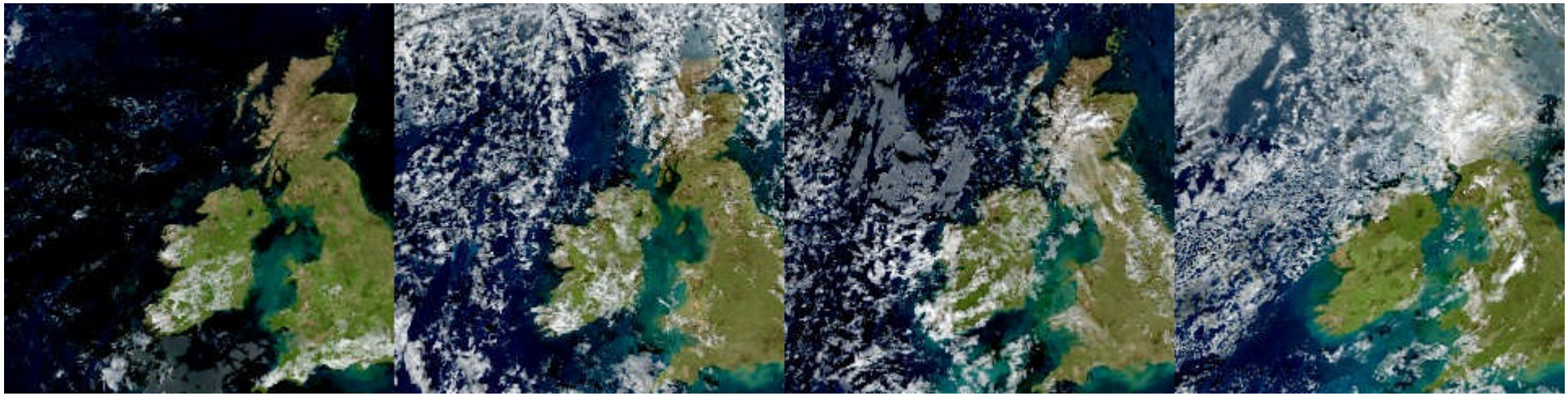

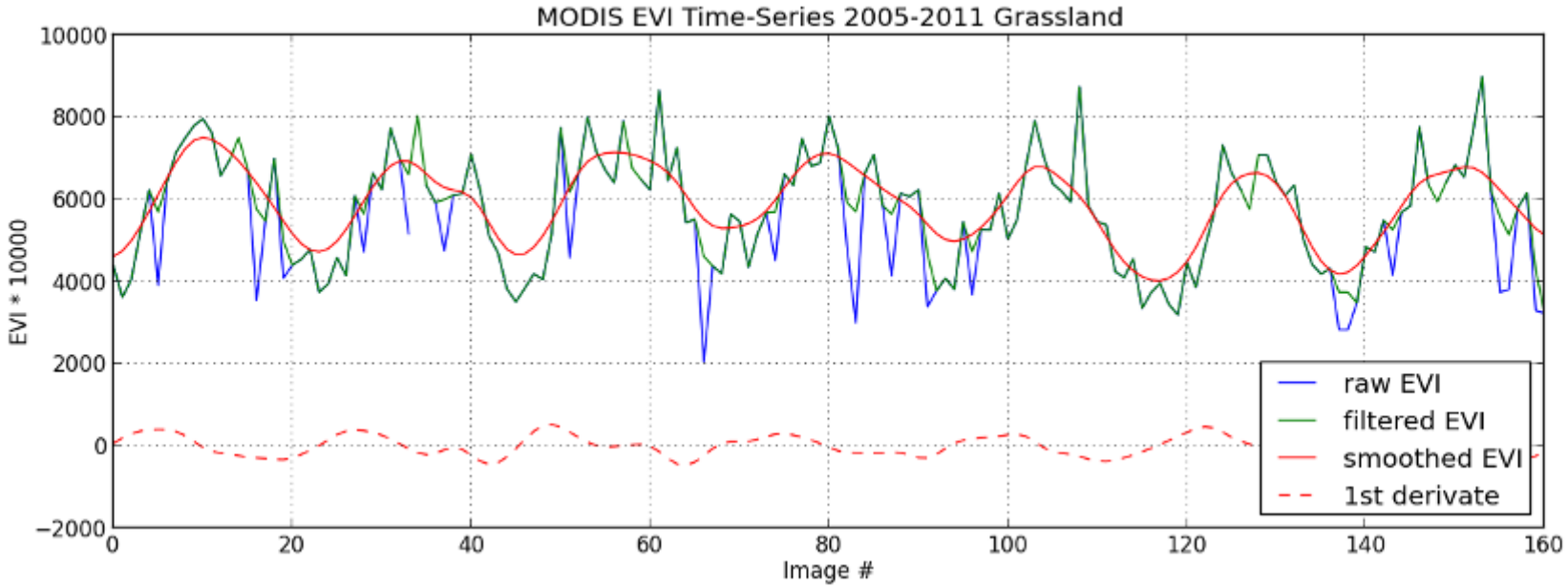

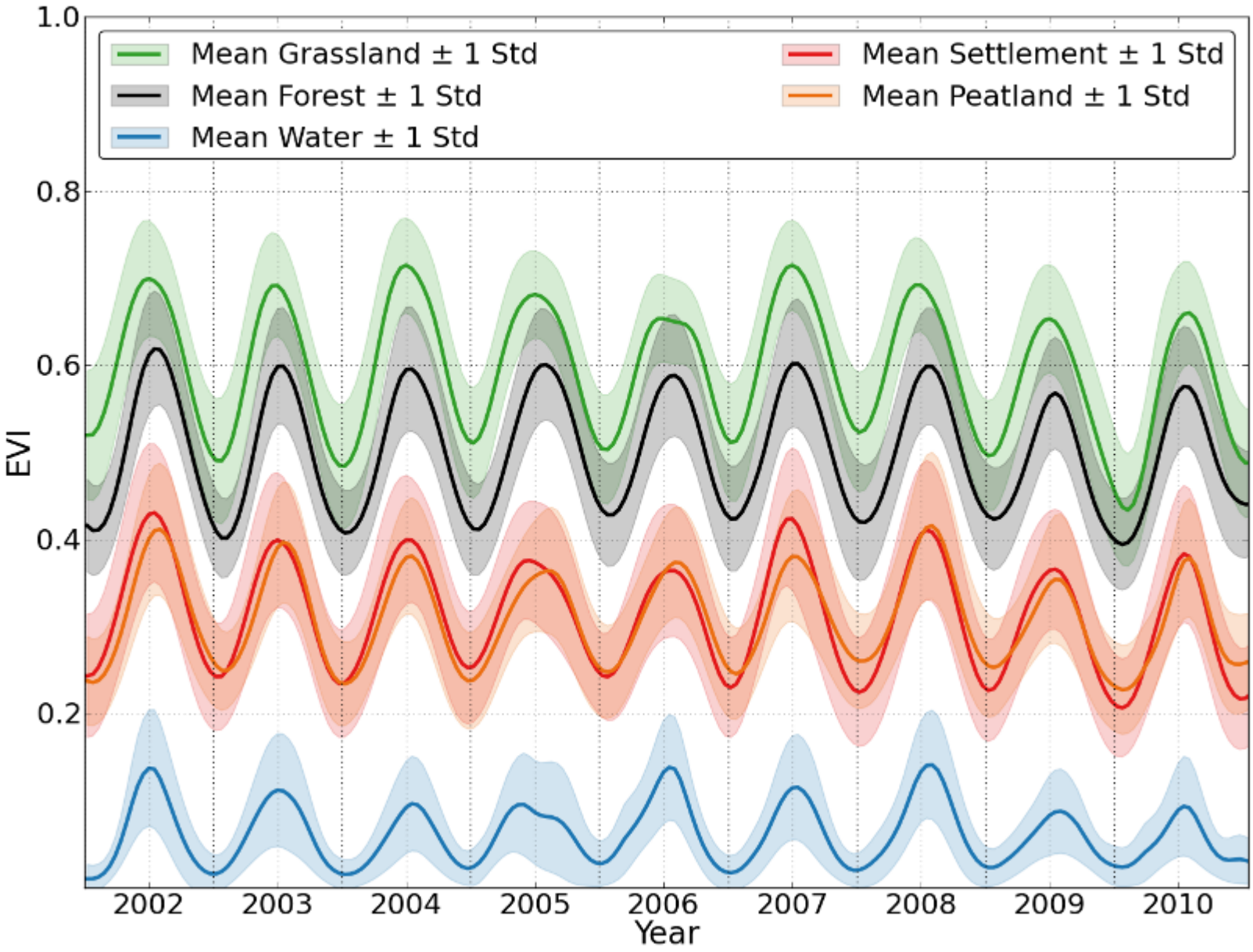
Mean Grassland ± 1 Std
Mean Forest ± 1 Std
Mean Water ± 1 Std
Mean Settlement ± 1 Std
Mean Peatland ± 1 Std
EVI
1.0
0.8
0.6
0.4
0.2
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

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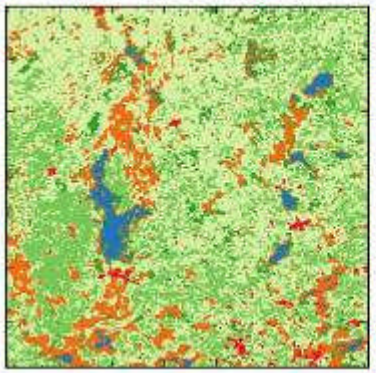
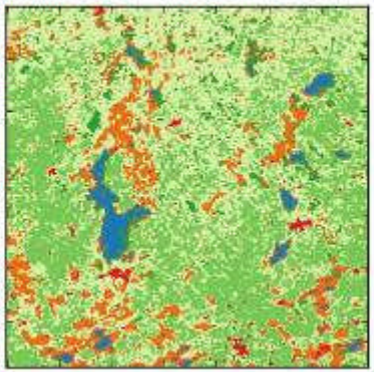


03



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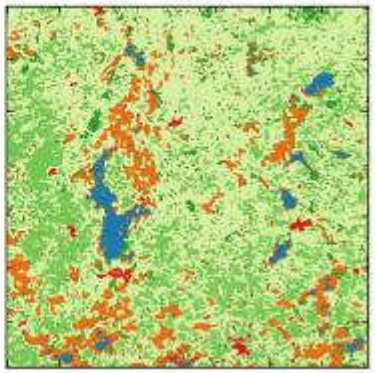

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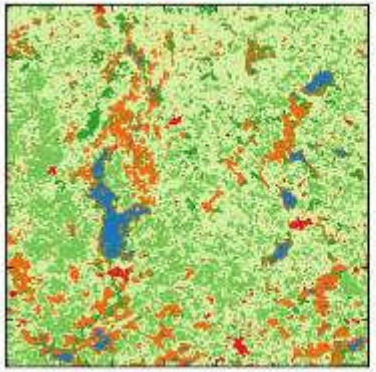

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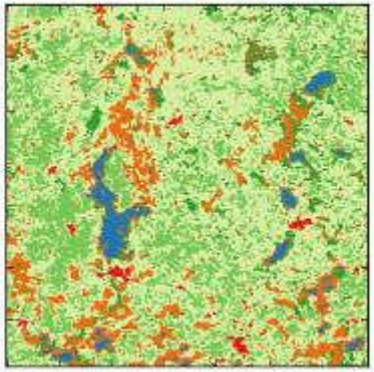

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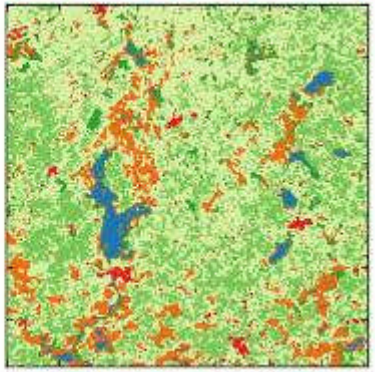

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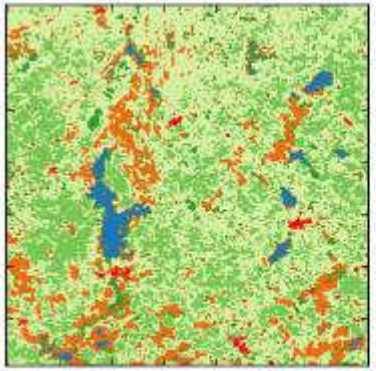

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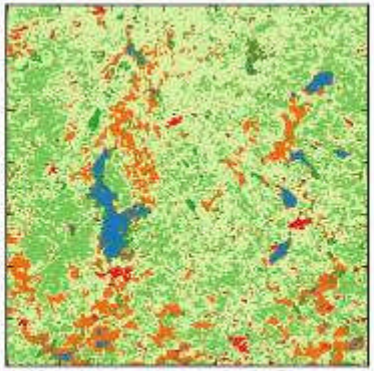

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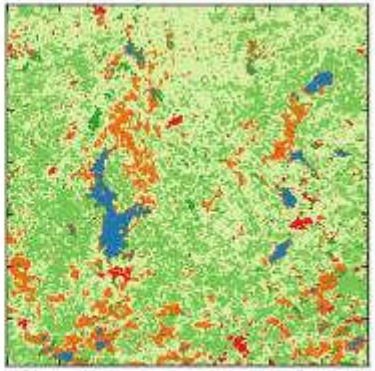

11

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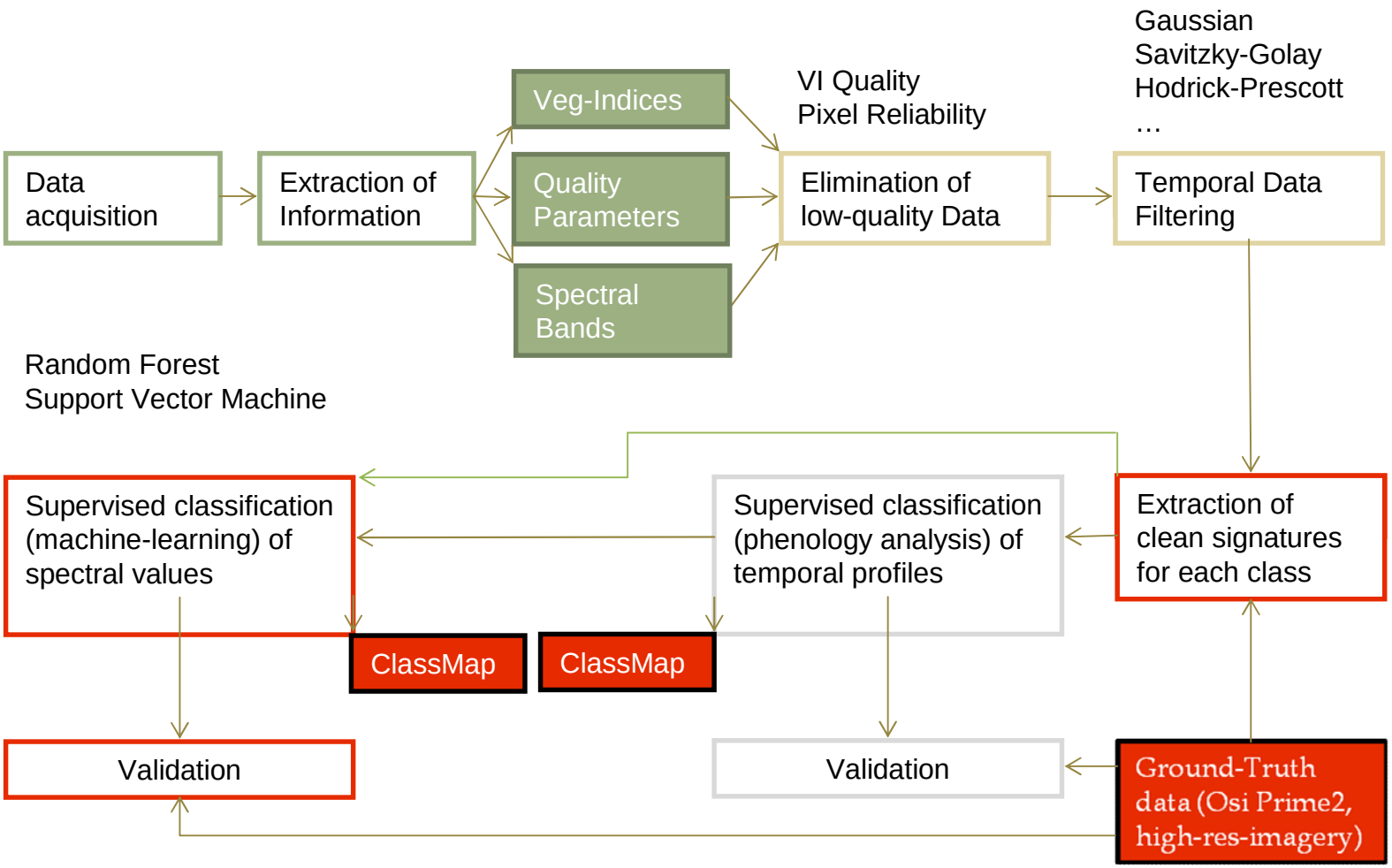
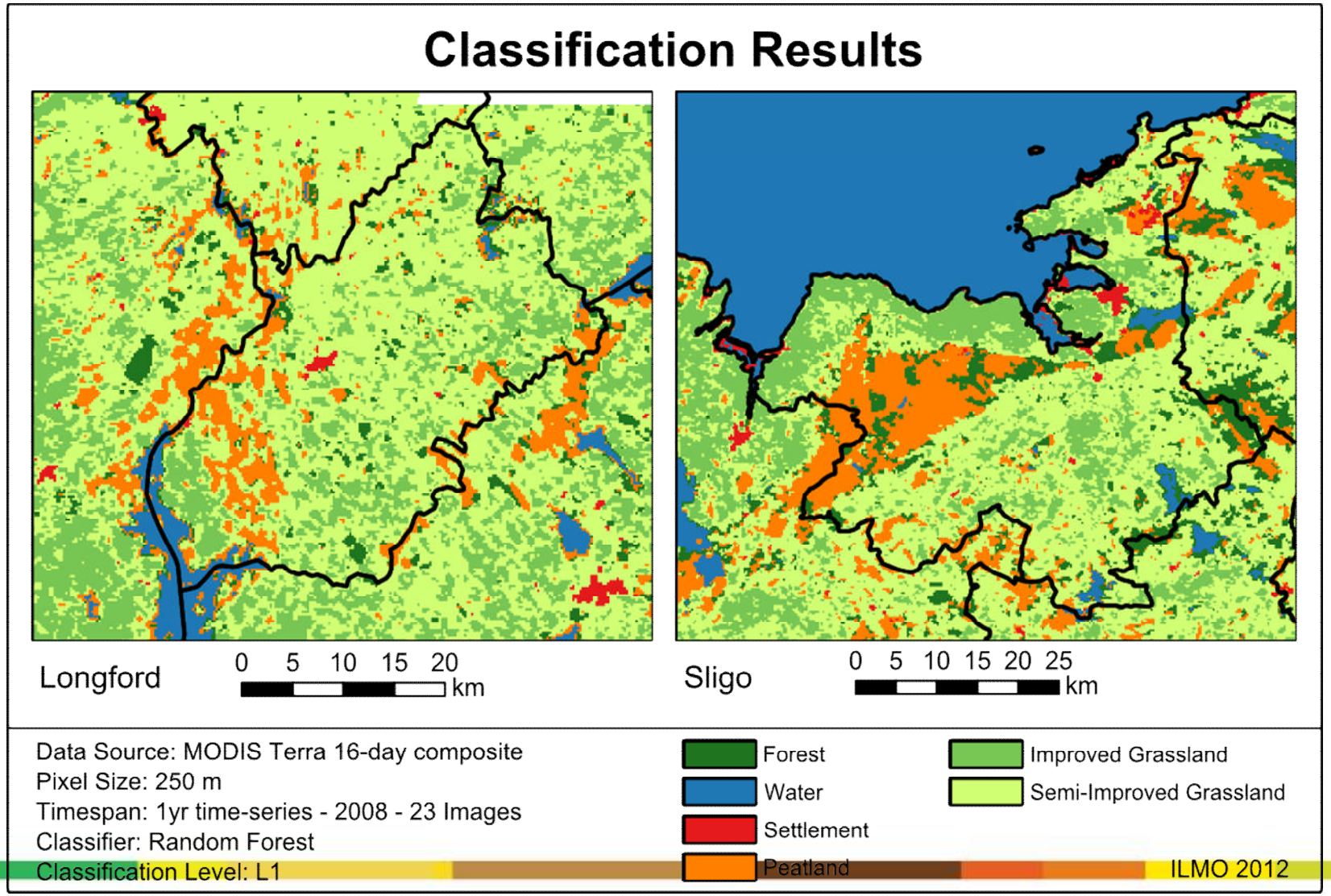

Data acquisition
Extraction of Information
Veg-Indices
Quality Parameters
Spectral Bands
VI Quality
Pixel Reliability
Elimination of low-quality Data
Gaussian
Savitzky-Golay
Hodrick-Prescott
…
Temporal Data Filtering
Random Forest
Support Vector Machine
Supervised classification (machine-learning) of spectral values
Supervised classification (phenology analysis) of temporal profiles
Extraction of clean signatures for each class
ClassMap
ClassMap
Validation
Validation
Ground-Truth data (Osi Prime2, high-res-imagery)



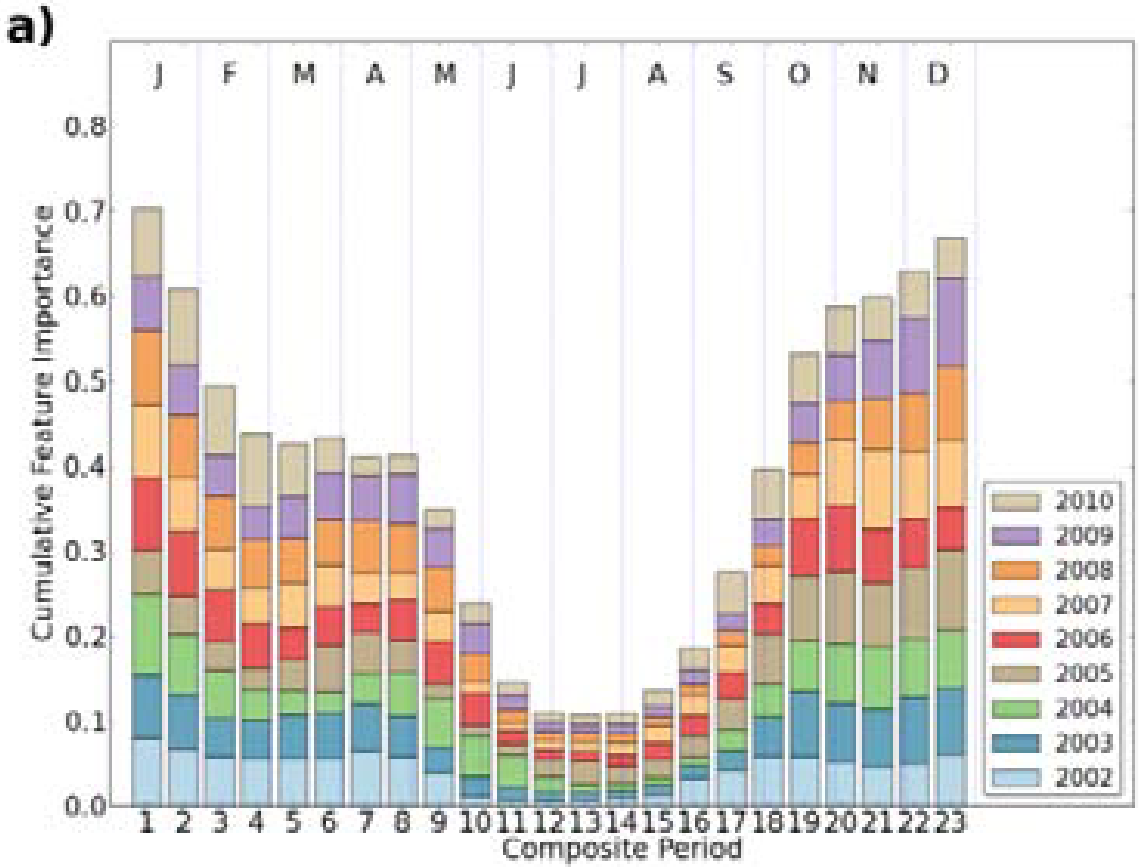
Optical Classification Map [RF] – 2008 only

Classification Results

Class	L1 – PPL0 – 11yr				L1 – PPL3 – 11yr			
	RF		SVM		RF		SVM	
	PA	UA	PA	UA	PA	UA	PA	UA
Forests	0.99	0.95	1.00	0.99	0.99	1.00	0.98	0.97
Water	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99
Settlement	0.96	0.99	1.00	1.00	0.99	0.99	0.96	0.97
Peatland	0.99	1.00	1.00	1.00	0.99	0.99	0.99	1.00
GA	0.98	0.97	0.99	0.97	0.98	0.98	0.99	0.99
GS	0.96	0.98	0.96	0.98	0.98	0.97	0.98	0.98
Overall Accuracy	98.8%		99.4%		99.1%		99.0%	
Kappa coefficient	0.98		0.99		0.99		0.99	

Class	Forest	Water	Settlement	Peatland	GA	GS
Forest	97	0	3	1	0	1
Water	0	320	0	0	0	0
Settlement	0	0	72	1	0	0
Peatland	0	0	0	319	0	0
GA	0	0	0	0	120	4
GS	0	0	0	0	2	119

- The optimisation of image acquisition dates for classification of vegetated landscapes in Ireland Ireland using the internal feature importance measures of the state-of-the art machine-learning learning method Random Forest proved to be a useful tool for removing redundancy within an within an annual time series and maximising the classification accuracy with minimal image image input. The temporal development and separability of the land cover signatures was reflected in the seasonal variability of the complementary classification accuracies.



Monitoring Events

Satellite systems can give national coverage and can measure biomass and the optical system offer daily revisits.

The Hyper temporal Optical data allows us to capture events in time and relate farm level descsions to satellite observations

Grassland management- Spring Turn Out date

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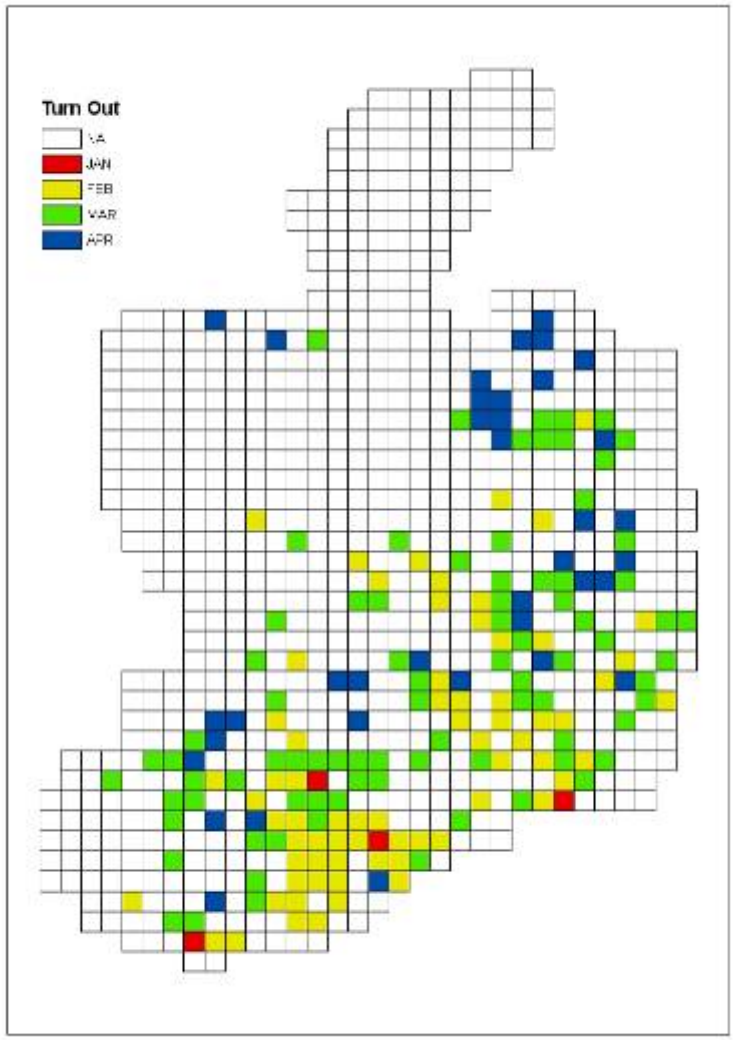

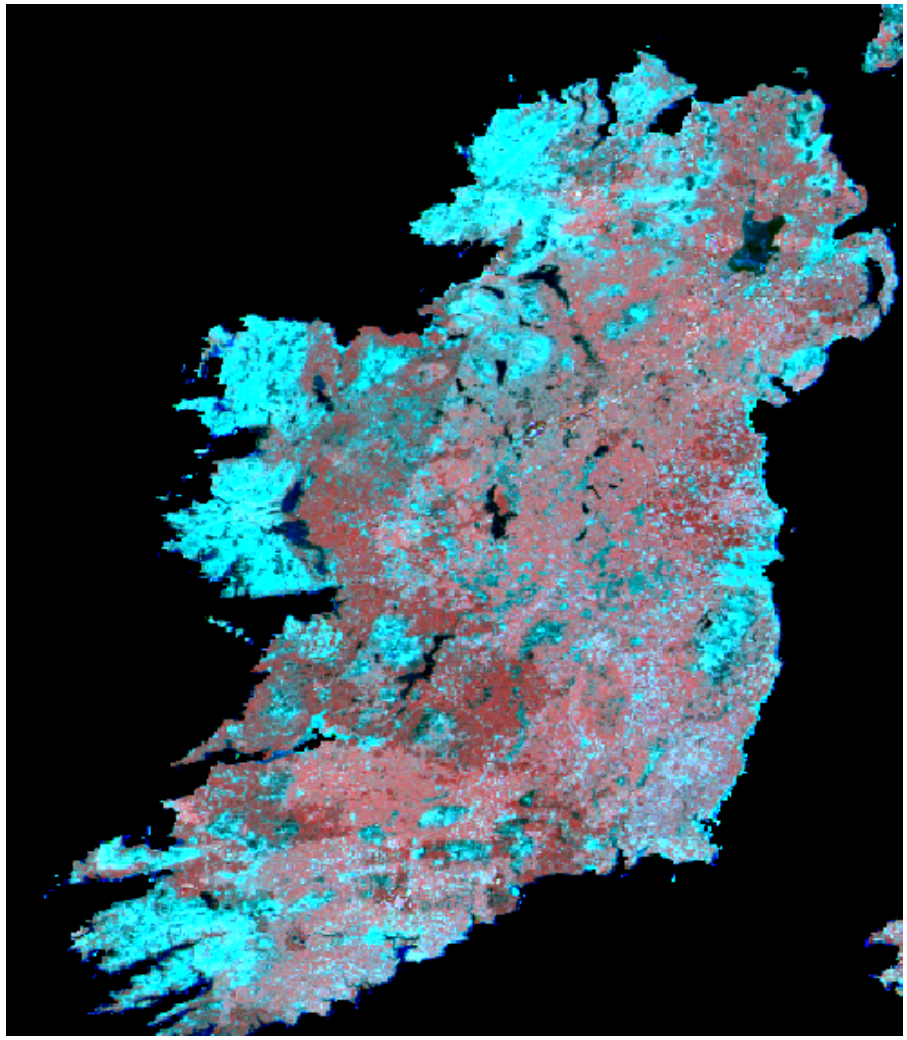

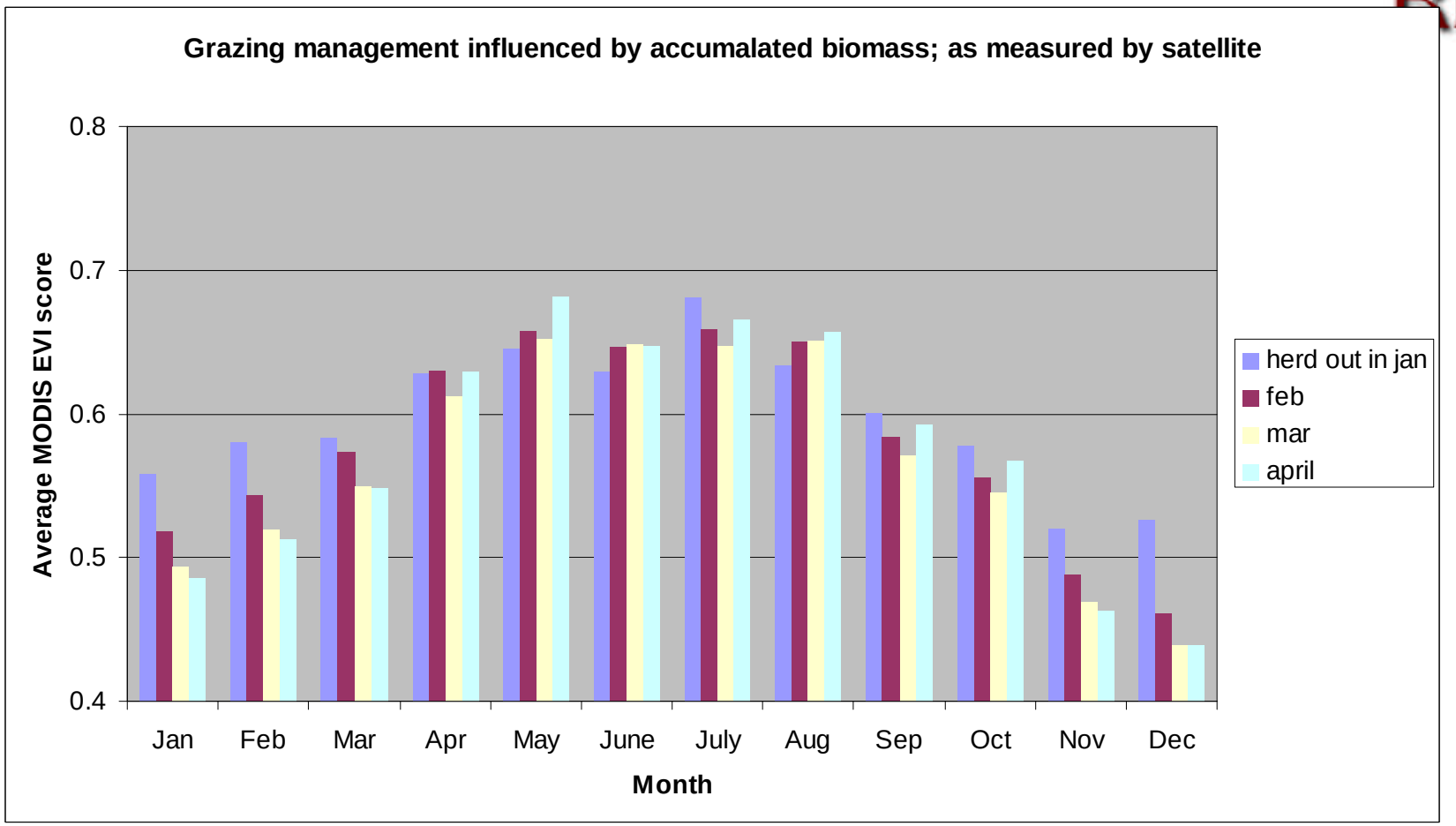
Grazing management influenced by accumalated biomass; as measured by satellite
Average MODIS EVI score
0.8
0.7
0.6
0.5
0.4
Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
Month
herd out in jan
feb
mar
april

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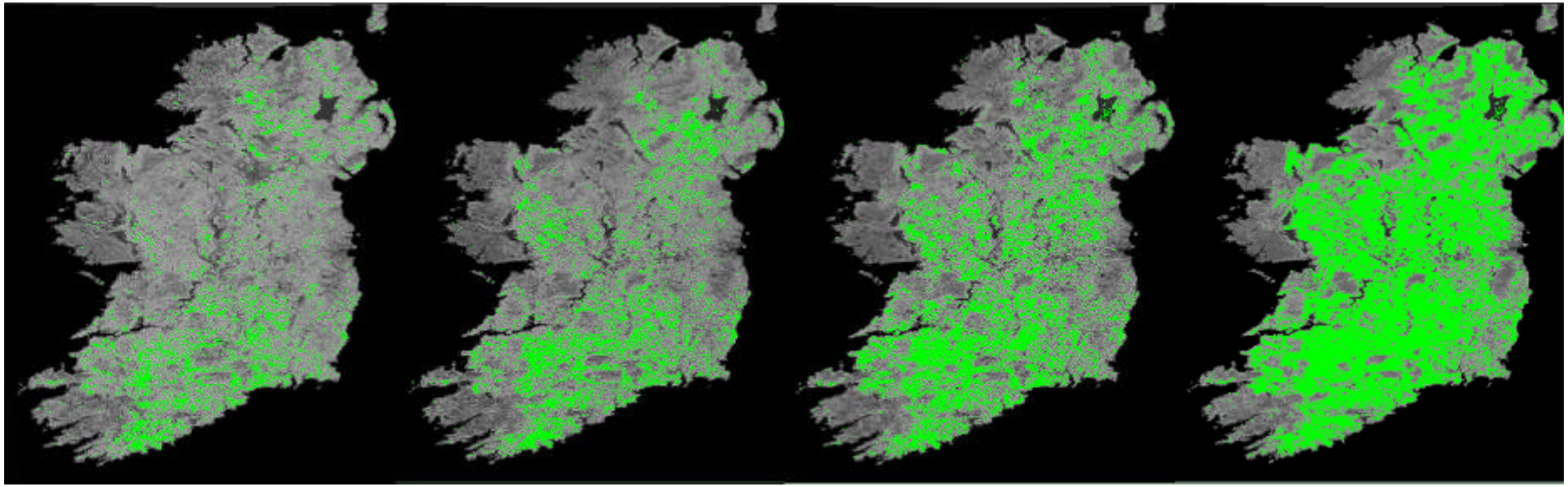
Results: Areas suitable for turning out



Jan Feb Mar Apr

Fodder Crisis: From policy to practice

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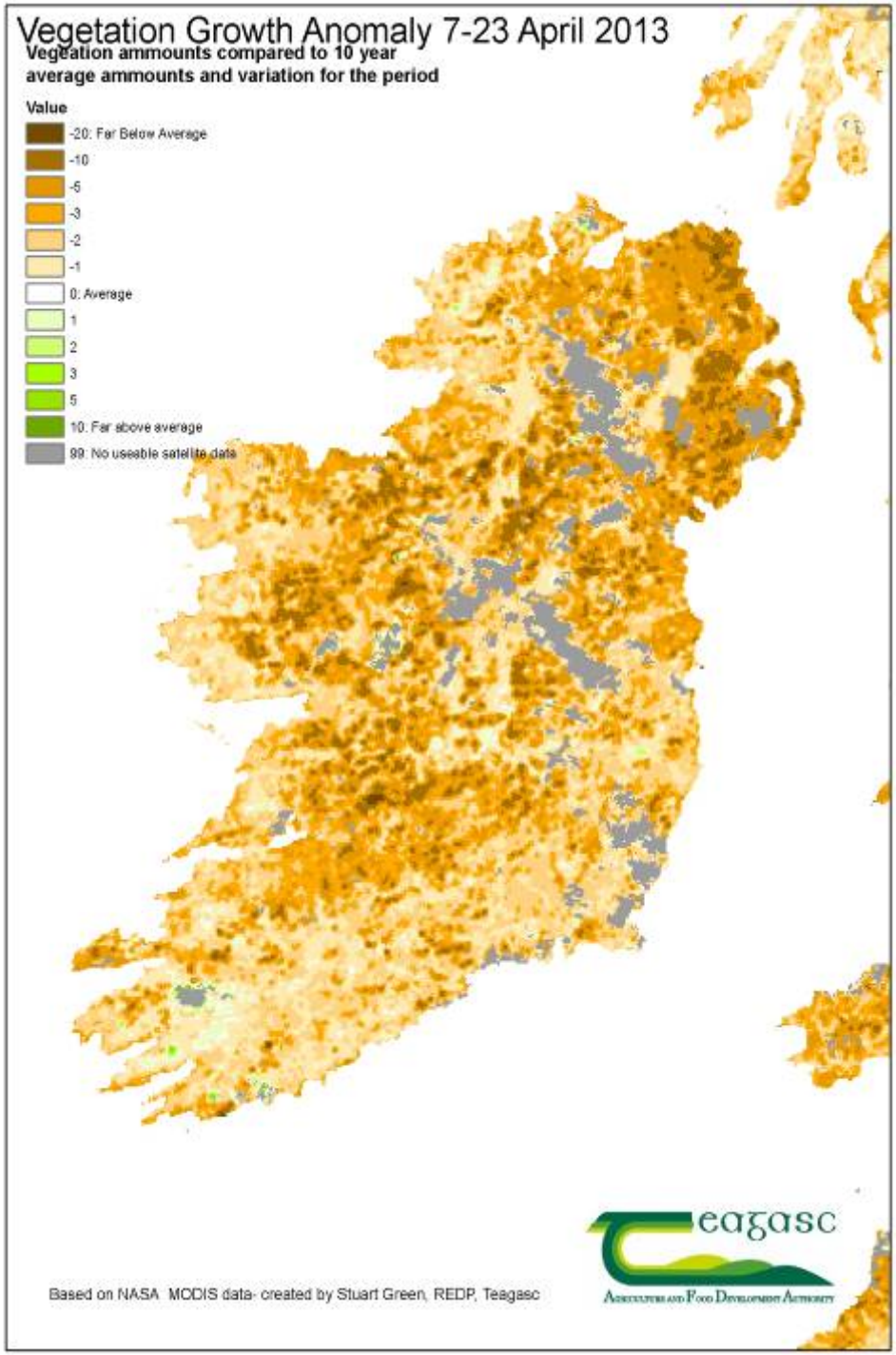
- A very wet autumn in 2012, a long winter and very late pricing created a animal feed/farm finance crisis.

- Overall almost 40% of all livestock farmers were severely affected by the forage forage crisis. This varies from 10-15% in the East to 20-25% in the South and up to up to 80% in the West and North West.

- Teagasc provided advice to clients and non-clients alike to address forage problems problems on farms. In the March-May period Teagasc advisors visited over 3,000 3,000 farmers, had consultations with 25,000 farmers and took over 45,000 phone phone calls. The online Mapping service with address locator allows for instant overview on behalf of the advisor.

Vegetation Growth Anomaly 7-23 April 2013

Vegetation ammounts compared to 10 year average ammounts and variation for the period



Based on NASA MODIS data- created by Stuart Green, REDP, Teagasc

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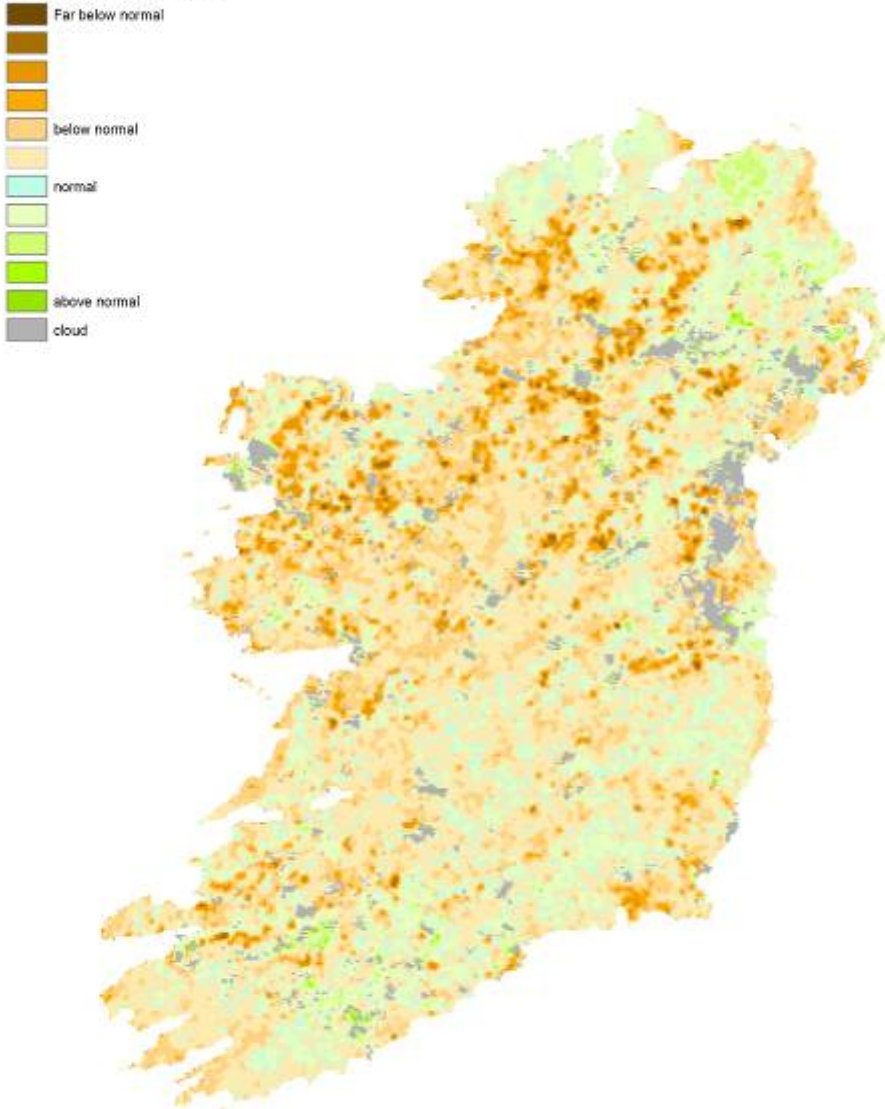
Agriculture and Food Development Authority

Vegetation Growth Anomaly 9 May-25May 2013

Vegetation Ammounts compared to normal performance



Based on NASA MODIS data- created by Stuart Green, REDP, Teagasc

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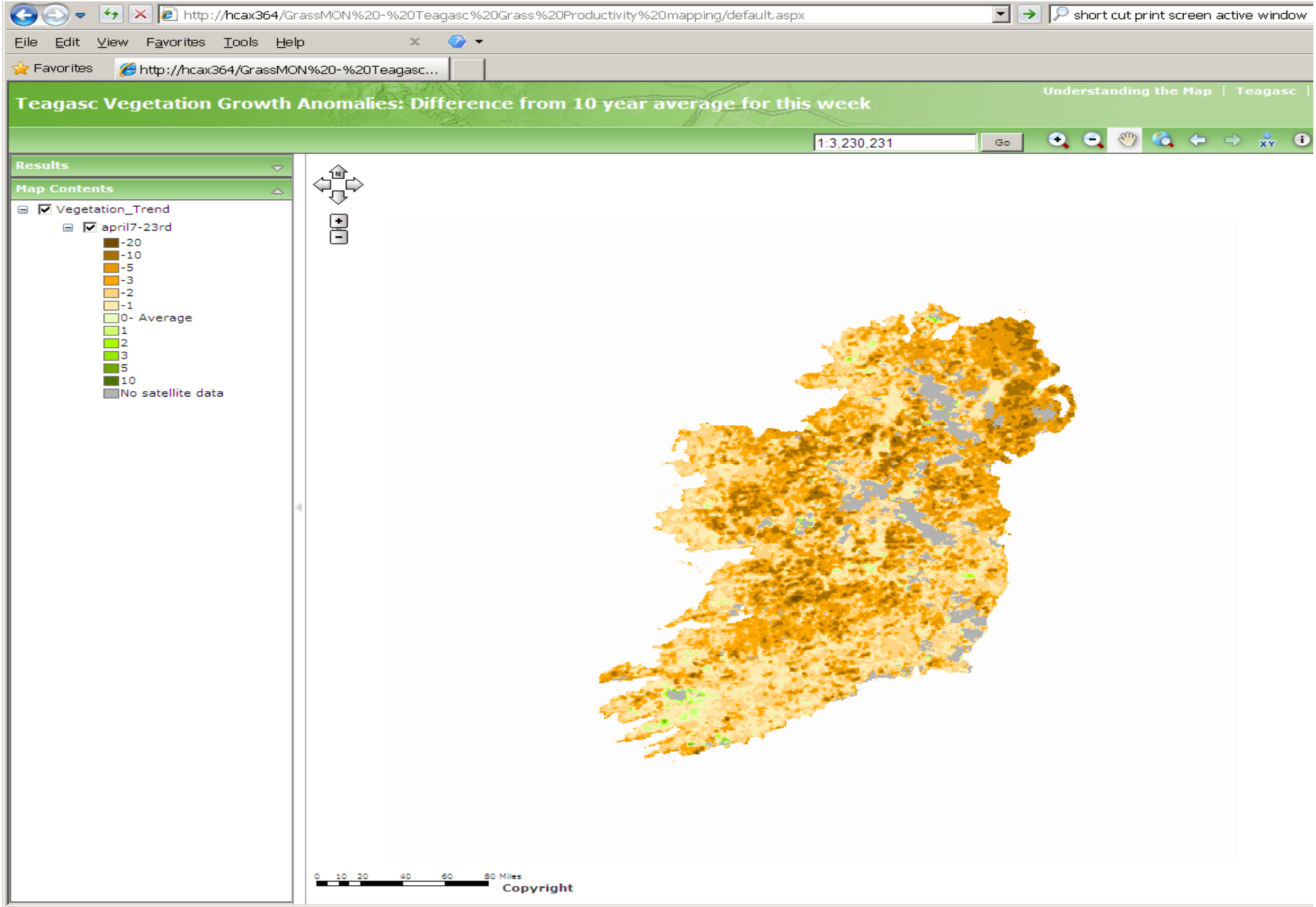
http://hcax364/GrassMON%20-%20Teagasc%20Grass%20Productivity%20mapping/default.aspx
short cut print screen active window
File Edit View Favorites Tools Help
Favorites
http://hcax364/GrassMON%20-%20Teagasc...
Teagasc Vegetation Growth Anomalies: Difference from 10 year average for this week
Understanding the Map | Teagasc |
1:3,230,231
Go
Results
Map Contents
Vegetation_Trend
april7-23rd
-20
-10
-5
-3
-2
-1
0- Average
1
2
3
5
10
No satellite data
0 10 20 40 60 80 Miles
Copyright
-596642.472, 6291466.802
Local intranet

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2015

- All Fields Tagged with Grassland Use-annual updates
- All Fields Tagged with Grassland Type-annual updates
- Annual Fodder Harvest Estimates
- Spring Turn out advice offered at local level
- Grass performance relative monitored on weekly basis
- Grass Performance absolute on weekly basis by 2016

- So ILMO is a direct response to a data need.
- It allows for existing policy to be evaluated and new policy developed.
- Its near real time monitoring means it can be used as an operational tool as as well as a policy one.
- We hope, by designing outputs that can be understood and discussed in a a conventional manner by farmers. The technology will be more easily adopted and this in turn will prompt farmers to adapt in ways that reinforce reinforce policy (especially regarding Harvest2020)

- Thank You