

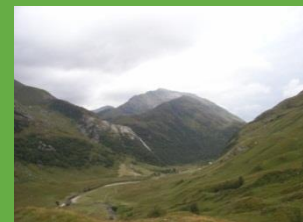
# The Internet of Agricultural Things (IoAT): a potential game-changer for farming in upland areas

**Professor Davy McCracken**

Head of SRUC's Hill & Mountain Research Centre

davy.mccracken@sruc.ac.uk

<https://twitter.com/DavyMcCracken>



*Leading the way in Agriculture and Rural Research, Education and Consulting*

# Innovation = Doing Things Differently



## Inbye grasslands

- *Soil pH and nutrients*
- *GHG emissions*
- *Grassland management*
- *Forage & fodder improvements*

## Hill grazing

- *Bracken control*
- *Improving hill parks*

## Sheep Performance

- *Genetic selections*
- *Blackface and Lleyn*

## Flock Performance

- *EID associated kit*
- *TST worming of lambs*
- *Comparison of system trade-offs*

## Auchtertyre flock

- *Restocking*
- *Blackloss*
- *Yellowses/Plochteach*

## Technology

- *Virtual fencing*
- *Drones for assessments*

## LoRa network

- *Tracking livestock*
- *Sensors*

# Systems approach to Precision Livestock Farming



Precision Agriculture and the Internet of Things (IoT)



# IoT: The Internet of Things

[https://www.iso.org/files/live/sites/isoorg/files/archiv/e/Ref2112/ref2112\\_infography\\_iot.png](https://www.iso.org/files/live/sites/isoorg/files/archiv/e/Ref2112/ref2112_infography_iot.png)

## The Internet of Things a very short story

The Internet of Things is the network of physical devices, vehicles, buildings and so on embedded with electronics, software, sensors and network connectivity that enable these objects to collect and transmit data via the Internet.

This year, 2016, we will have **4.9 billion** connected things, so get ready, the Internet of Things is here to stay

Companies like **Google** and **Samsung** are investing in home devices and having a connected kitchen could save the food and beverage industry as much as **15 %** annually

The global wearable device market has grown **223% in 2015**

According to some estimates, the Internet of Things will add **USD 10-15 trillion** to global GDP in the next **20 years**

**By 2020,**  
**250K** vehicles  
will be connected  
to the Internet

Google's self-driving cars average about **10 000 autonomous miles** per week

ATMs were some of the **first** Internet of Things objects as far back as **1974**

The "Internet of Things" is a phrase that **87 %** of people haven't heard of

Back in **2008**, there were already more objects connected to the Internet than people

Based on "12 Internet of Things Facts Everyone Should Read" by Bernard Marr



# IoT: The Internet of Things

## Geolocation Solution in Glasgow



# IoT: The Internet of Things

<https://www.nesta.org.uk/blog/precision-agriculture-almost-20-increase-income-possible-smart-farming>

## FUTURE FARMS small and smart

### SURVEY DRONES

Aerial drones survey the fields, mapping weeds, yield and soil variation. This enables precise application of inputs, mapping spread of pernicious weed blackgrass could increase Wheat yields by 2-5%.

### FLEET OF AGRIBOTS

A herd of specialised agribots tend to crops, weeding, fertilising and harvesting. Robots capable of microdot application of fertiliser reduce fertiliser cost by 99.9%.



### FARMING DATA

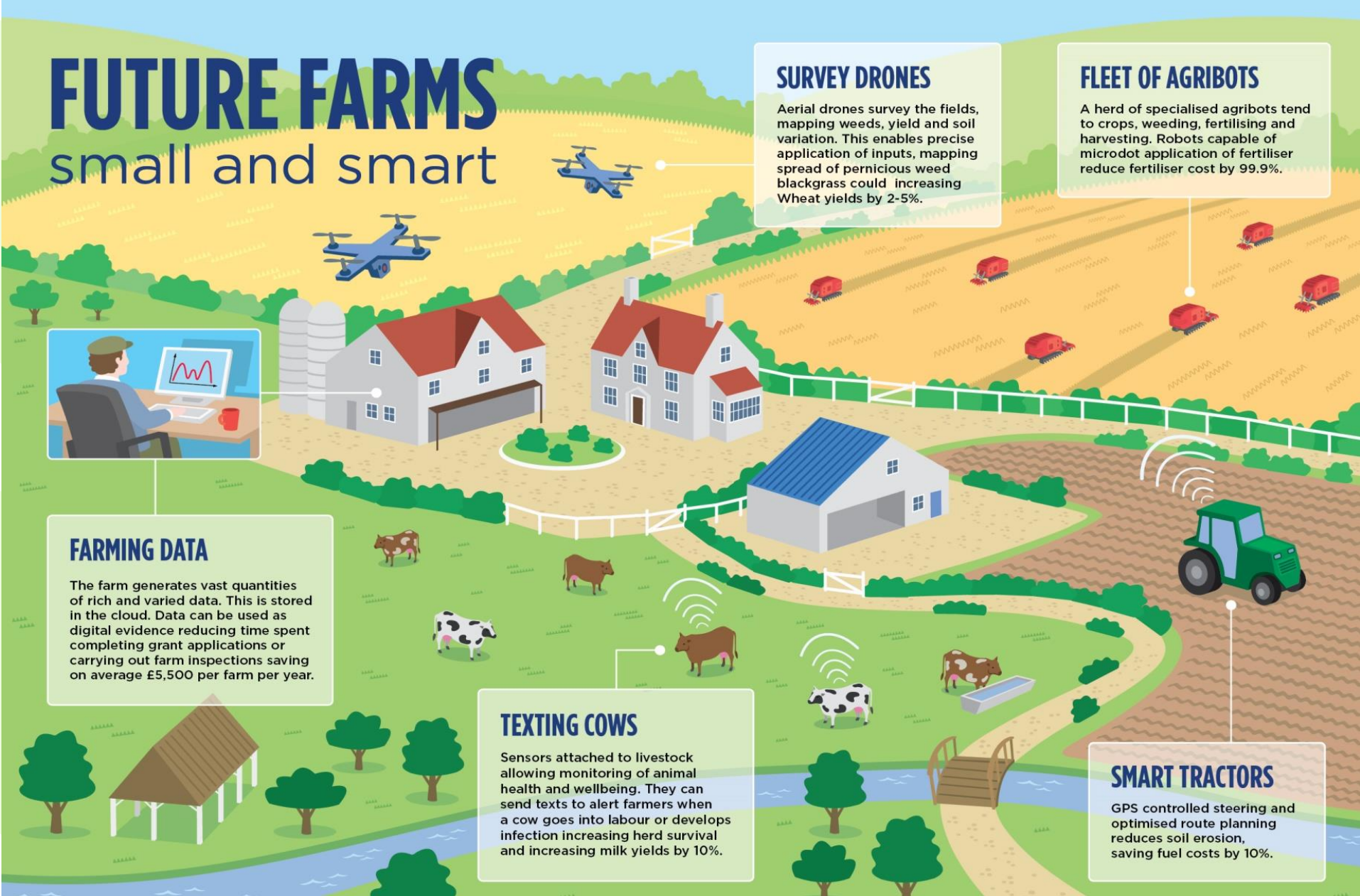
The farm generates vast quantities of rich and varied data. This is stored in the cloud. Data can be used as digital evidence reducing time spent completing grant applications or carrying out farm inspections saving on average £5,500 per farm per year.

### TEXTING COWS

Sensors attached to livestock allowing monitoring of animal health and wellbeing. They can send texts to alert farmers when a cow goes into labour or develops infection increasing herd survival and increasing milk yields by 10%.

### SMART TRACTORS

GPS controlled steering and optimised route planning reduces soil erosion, saving fuel costs by 10%.





# Scottish uplands



## Land Capability for Agriculture in Scotland

- Arable
- Mixed agriculture
- Grassland
- Rough Grazing
- Built up areas
- Inland water

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Map produced by Steven Thomson  
SRUC (2016)





# Hill farming & crofting face a variety of challenges:



## Range of agricultural production challenges, e.g.:

- Low productivity
- Poor nutrition
- Pests and Disease
- Climate change
- Predation
- Blackloss

Low lambing percentages in spring and/or Low survival of lambs through to autumn

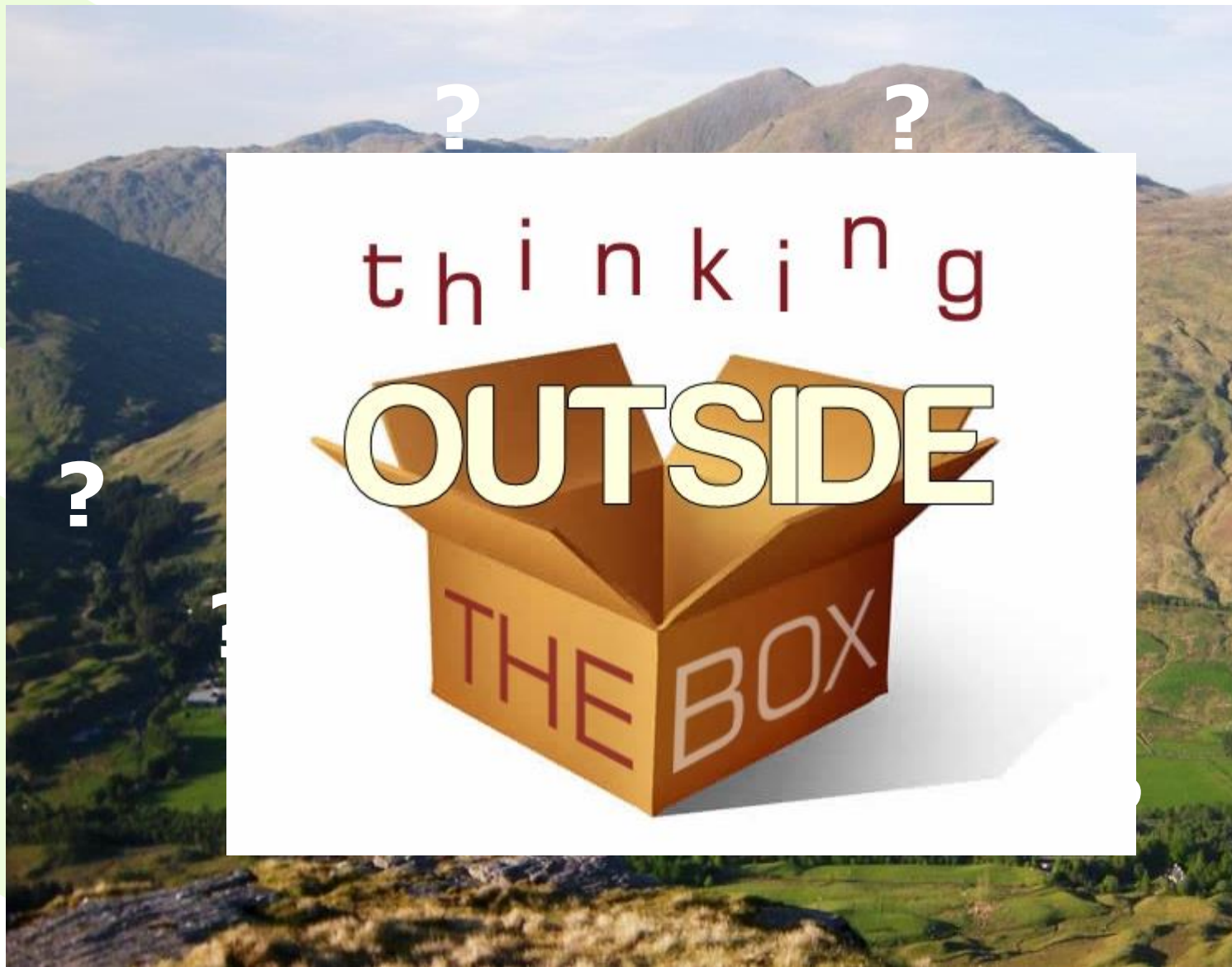




# Range of public goods which hill farming & crofting has a role in providing:



# Data Collection a Challenge





# Loch Lomond and The Trossachs National Park Boundary

## Legend



National Park boundary



Local Authority boundary

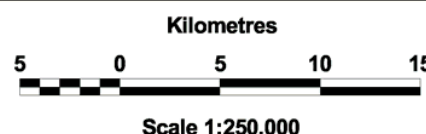
Argyll & Bute

SRUC Kirkton and Auchtertyre

Perth & Kinross

Stirling

West  
Dunbartonshire



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For further information please contact the appropriate authority.



## Environment

Area: 2225 ha

Altitude: 180 - 1025 m

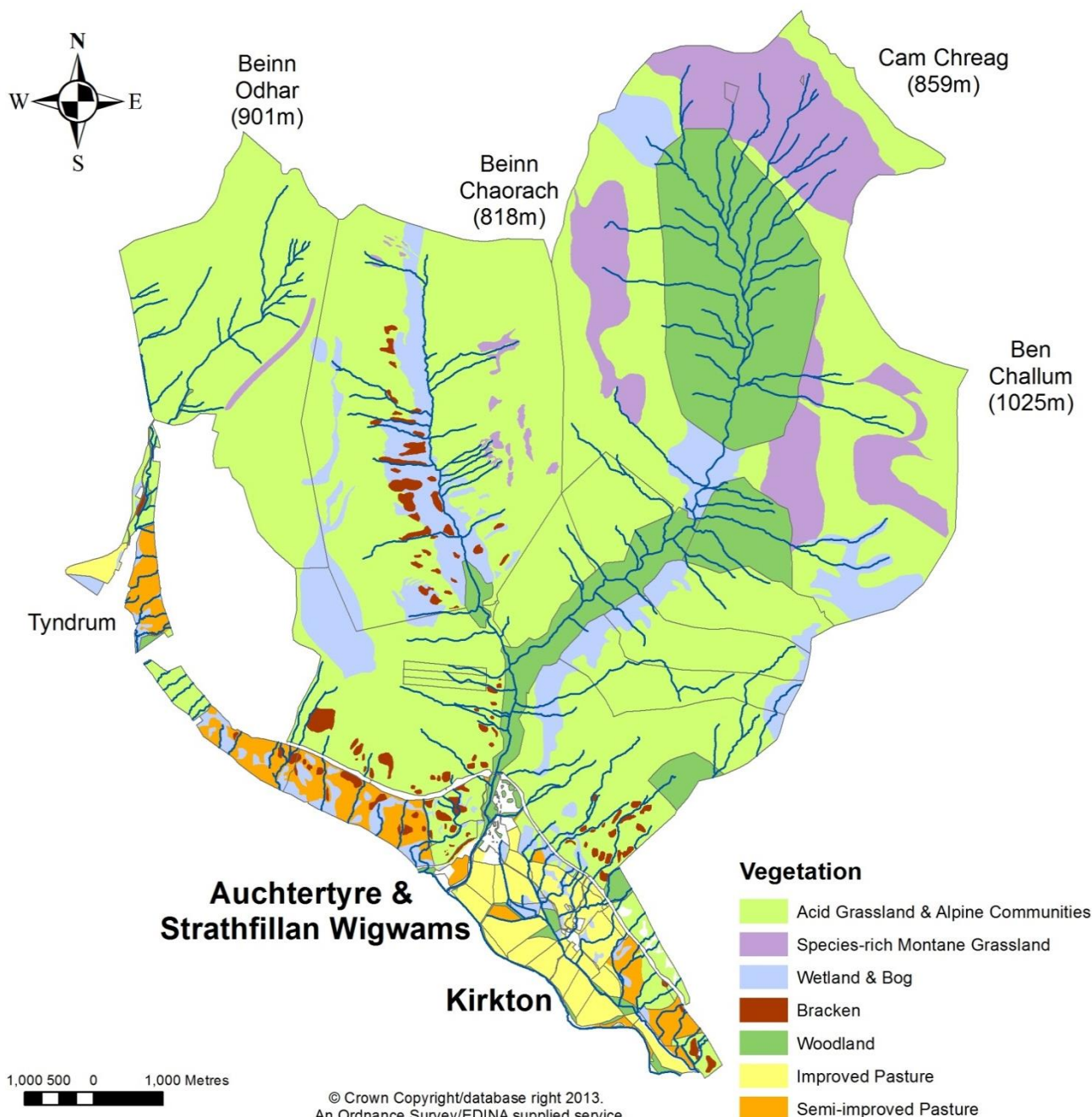
1 Munro (>3000 ft) – Ben Challum (1025 m)

3 Corbetts (>2500 ft) – Ben Odhar (901 m); Cam Chreag (884 m); Ben Chaorach (818 m)

3 river catchments

Woodland expansion late 1990s

## SRUC's Kirkton & Aughtertyre upland research farms



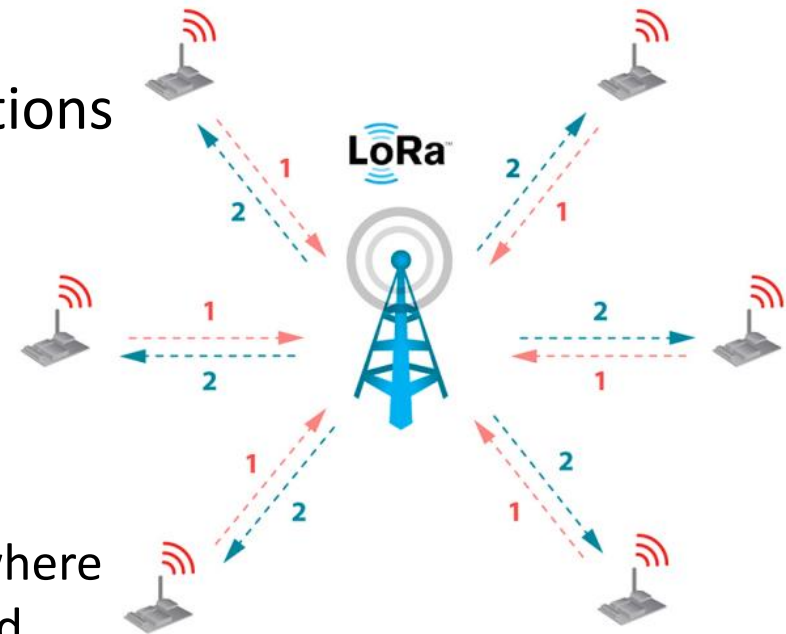


# Internet of Things



## LoRaWAN

- long range/low power communications platform
- >10 miles range in rural areas
- ideal for
  - deployment of sensors and devices where small amounts of data are transmitted periodically
  - when a given event occurs.



Precision Agriculture  
and the  
Internet of Things (IoT)



# IoT: The Internet of Things

## Scotland: a nation with ambition

[Scotland: a nation with ambition](#), published earlier this month, lays out the Scottish Government's programme of action for 2017-18.

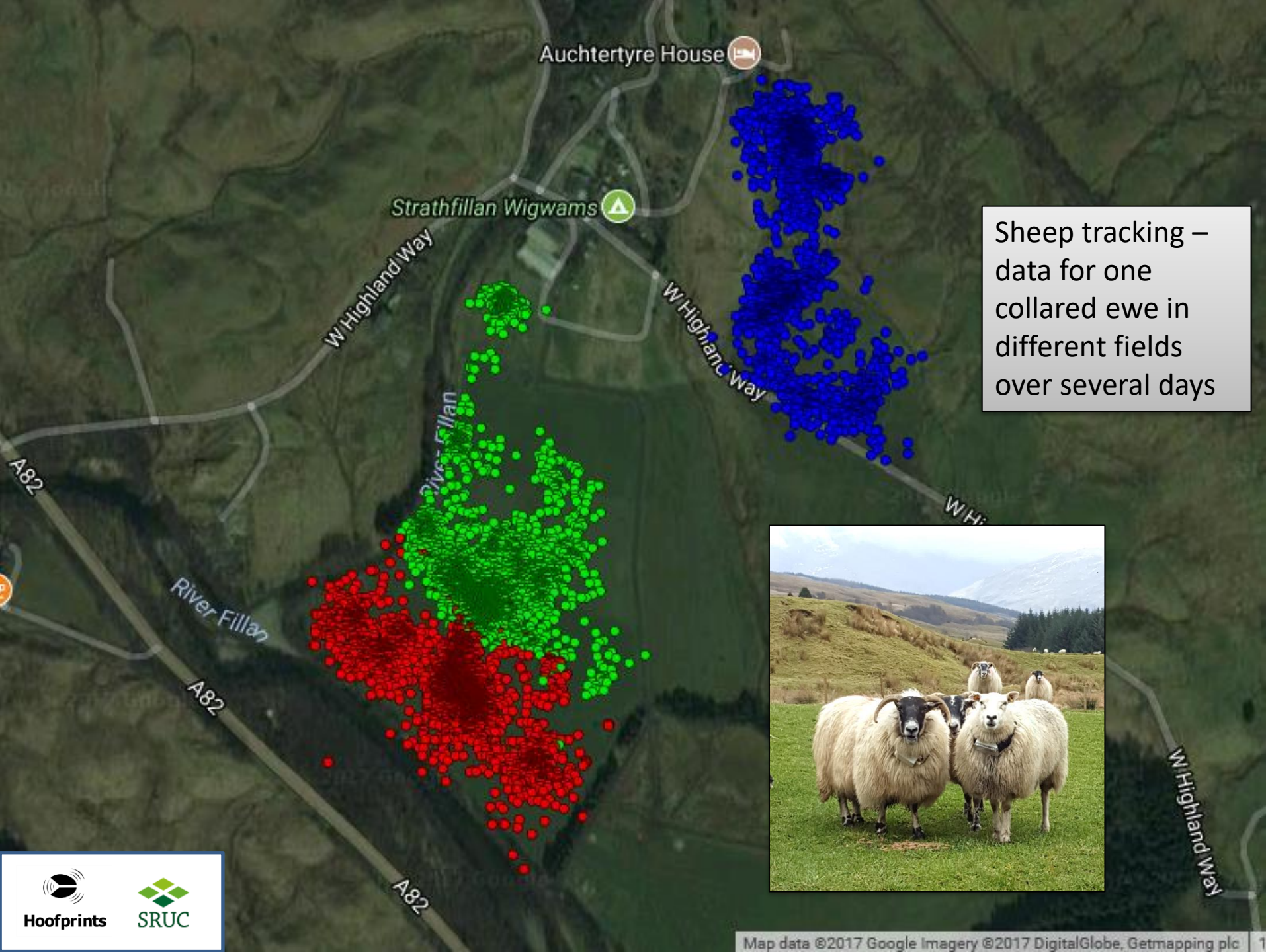
The government's economic ambition to build a modern, dynamic, open economy recognises the need to innovate, stay ahead of the competition and create jobs. We were pleased to see CENSIS mentioned on page 45, acknowledging us as an organisation that "supports Scottish businesses to develop their ideas and secure commercial opportunities by forging partnerships with universities and economic development agencies".

The Internet of Things and IoT networks are a key building blocks for industrial digitalisation and, also on page 45, the Programme notes the Scottish Government's commitment to "invest in a new and more supportive wireless sensor network. This national resource will transform the potential for businesses to explore sensor and imaging applications, to pilot their ideas and then launch proven, sustainable products and services into the global market."

The [Scottish Government's Digital Strategy for Scotland](#), published in March 2017, notes its ambition to "develop a national LoRa-wide area network that supports Machine-to-Machine networking and puts Scotland at the cutting edge of the Internet of Things, while supporting our businesses to innovate and take full advantage of the economic opportunities offered by IOT." See page 22 of the document for more information.

**A NATION  
WITH AMBITION**  
THE GOVERNMENT'S  
PROGRAMME FOR SCOTLAND  
**2017-18**





Sheep tracking –  
data for one  
collared ewe in  
different fields  
over several days





Tracks:

☒ extract 8 acre 20 21 may 10  
rolling average 



Hoofprints



SRUC



# LoRaWAN™ network: potential use cases



**Livestock tracking: alerts to off-farm movements**

**Alerts to low levels in fuel/water storage tanks**

**Tree growth & health**

**Array of soil temperature & moisture sensors: nutrient and grassland management**

**Water turbidity/dissolved oxygen: alerts to pollution incidents**





# LoRaWAN™ network: potential use cases



**Snow depth and cover**

**Peatland restoration and tracking of ecological recovery**

**Water depth/flow: alerts of flooding risk further downstream**

**Weather & conditions in key habitats: localised predictor of liver fluke, tick, blowfly risk**





# LoRaWAN™ network: other queries?



**Upland bird nest monitoring?**

**Direct damage to trees?**

**Deer movement?**

**Highlighting location of ground-nesting  
bird nests in fields so machinery  
avoids?**



# Rewarding the delivery of public goods?



Outcome/Results  
based approaches?

Historic agri-environment  
prescriptive approaches?

Continuing general support for farmers?

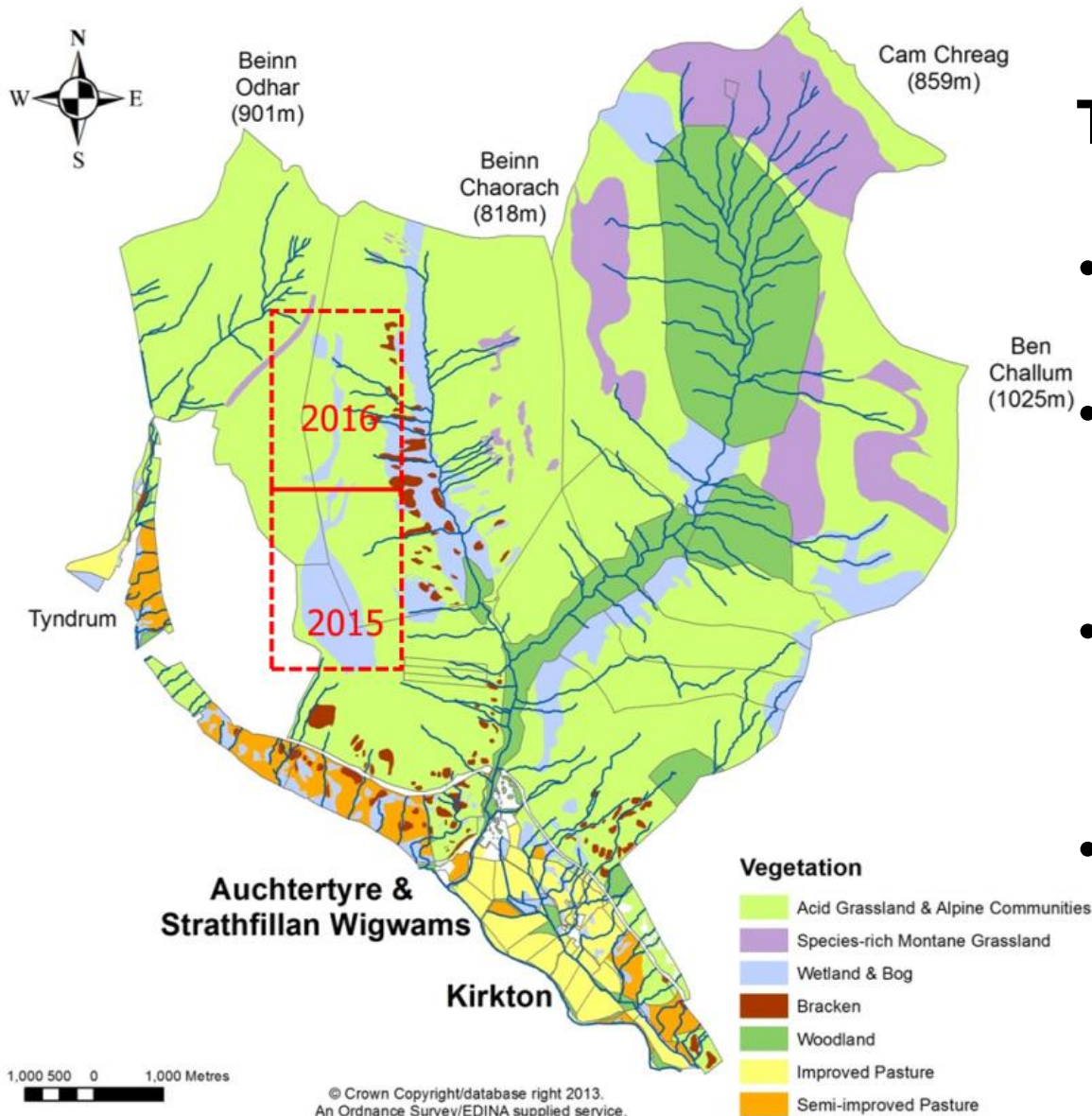
Combination of all three above?

Need to be cost-effective and transparent





# High altitude peatland restoration



## Total 2015 and 2016:

- c. 104 ha restored
- Over 15 km peat hag reprofiled
- Construction over 80 dams to rewet peat
- Revegetation of two large peat pans

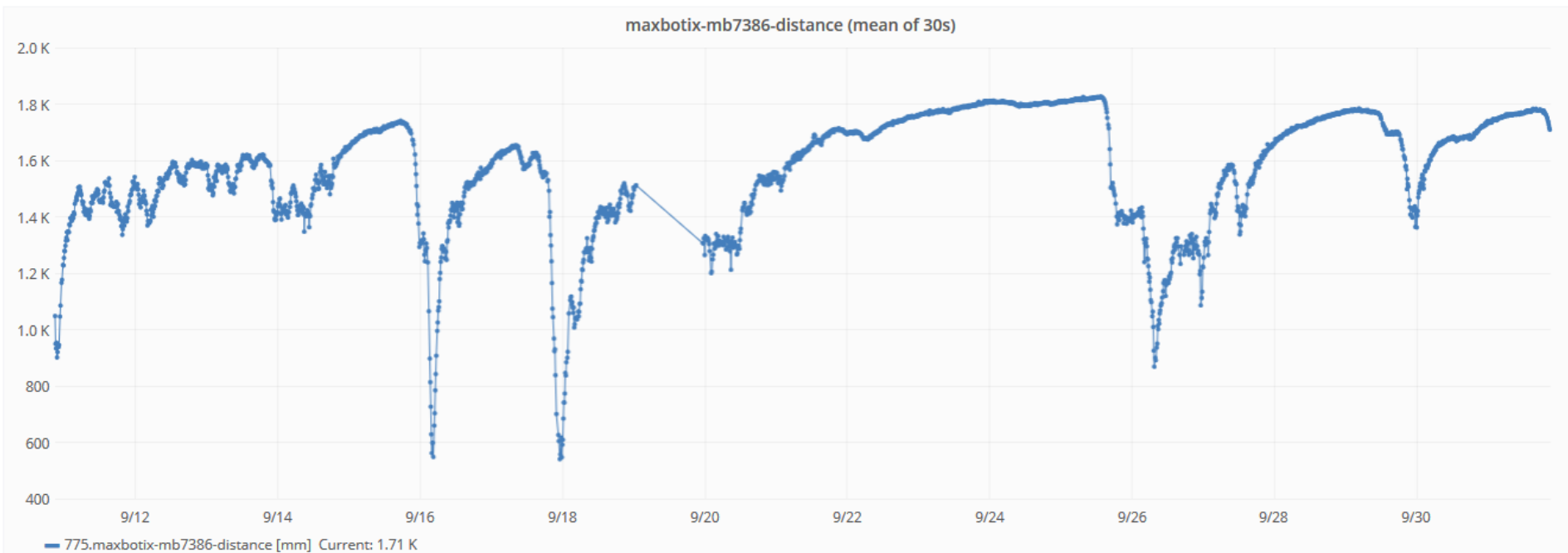
# Height of water in main river



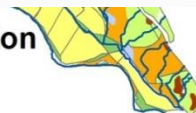
Beinn  
Odhar  
(901m)



Infrastructure and services by  
 decenLab



Kirkton



- Wetland & Bog
- Bracken
- Woodland
- Improved Pasture
- Semi-improved Pasture

1,000 500 0 1,000 Metres

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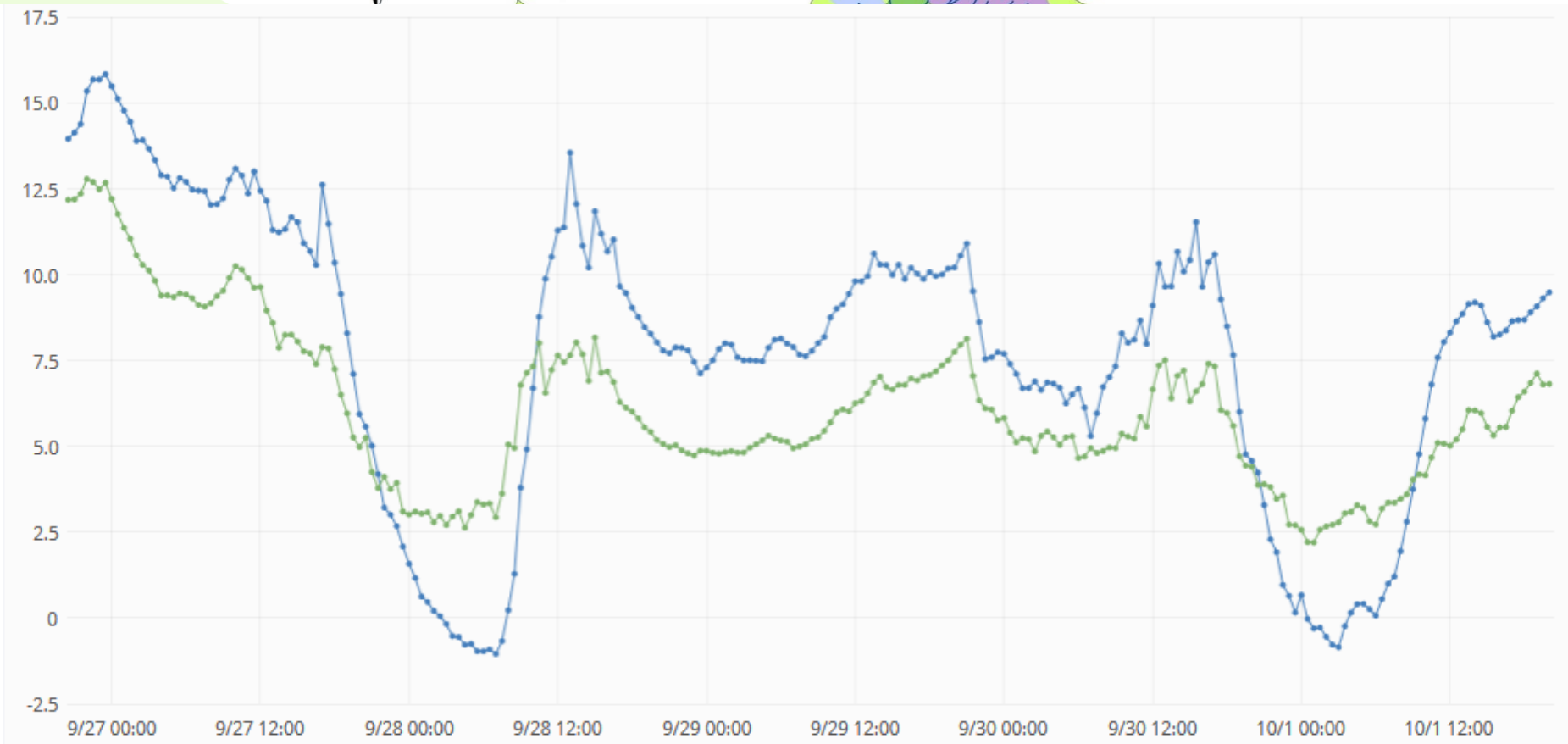
# Air temperature: 170 m and 550 m



Beinn  
Odhar  
(901m)



Cam Chreag  
(859m)



1,000 500 0 1,000 Metres

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- Woodland
- Improved Pasture
- Semi-improved Pasture

# Innovation = Doing Things Differently



Precision Agriculture  
and the  
Internet of Things (IoT)



- Minimising costs / maximising production efficiency
- Promoting sustainability
- Livestock welfare
- Economic viability of farms
- Environmental compliance



## Engineering & Technology

Systems  
& ecology



Knowledge  
Transfer



## Biological Sciences



For more detail see: [http://www.sruc.ac.uk/news/120252/hill\\_and\\_mountain\\_research\\_centre](http://www.sruc.ac.uk/news/120252/hill_and_mountain_research_centre)



# Acknowledgements

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