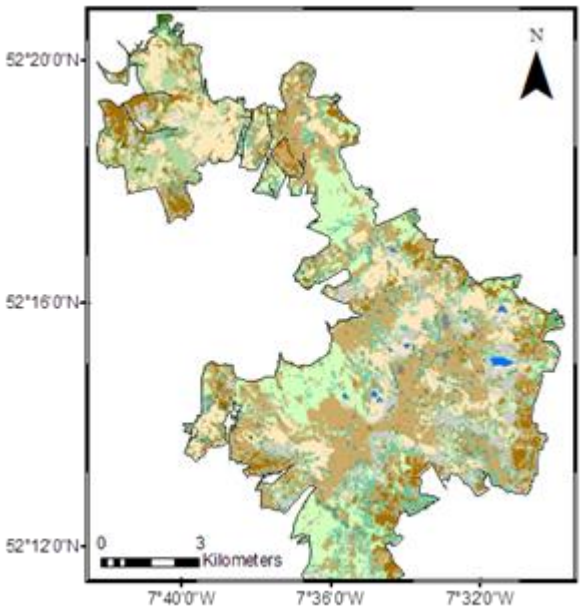
Project number: 6638
Funding source: EPA

Date: Nov 2016
Project dates: May 2014-April 2016

TALAM: Mapping Irish uplands through satellites.



Key external stakeholders:
DAFM, EPA, NPWS, NGO's, Upland Farmers

Practical implications for stakeholders:
This work forms part of a methodological infrastructure for a national land cover mapping system.

- This project has designed the methods needed to reliably map the landcover and habitats of all Ireland's unenclosed upland areas.

Main results:

A successful method for mapping unenclosed areas with remote sensing has been built.

Publically available landcover maps of = Mount Brandon, the Galtee Mountains, the Comeraghs and the Suir Catchment are now available.

Stakeholder workshops have captured preferred mapping characteristics and these will inform the future national landcover and habitat map.

Opportunity / Benefit:

The results of project have cleared the last technological hurdle leading to completion of a national land cover/habitat map.

As an interim to a national map, the area maps of Mount Brandon, the Galtee Mountains, the Comeraghs and the Suir Catchment are now available.

Collaborating Institutions:

UCC

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1. Project background:

Ireland is one of the few countries in Europe not to have a national program for mapping land cover and land use. Such maps are neede to improve e.g. agricultural management, environmental management, policy implementation, and calculation of greenhouse gas budget.
TALAM is the last in a series of projects designed to resolve certain technical issues before a full scale national mapping program is commenced.

2. Questions addressed by the project:

TaLAM, **T**owards **L**andcover **A**ccounting and **M**onitoring, is part of Ireland's response to creating a national landcover mapping program. It aimed to show how the new digital map of Ireland, Prime 2 from the Ordinance Survey of Ireland (www.geohive.ie), could be combined with satellite imagery to produce land cover maps in unenclosed areas. These are upland areas and are largely featureless in OSI mapping, being labeled as "Mount Brendan" with only perhaps streams, tracks and forests mapped. It was very successful in this regard.

3. The experimental studies:

The OSI Prime 2 maps all the country seamlessly, every road, every building, every field as separate *objects* but in mountain areas there are no objects; Prime 2 leaves them blank. Therefore one important objective of the TALAM project was to design a method that could fill in the blanks and map the landcover in these large unenclosed ("objectless") areas.

Three strands were explored:

i. Consensus building of key stakeholders to understand what they needed from a map and also to raise awareness on what is possible using the remote sensing methods proposed.
ii. Testing new ways of using optical methods to create artificial segmentation of the large upland areas.
iii. Classifying land cover and habitats in these areas from optical and remote sensing satellites.

The data for "filling in the blanks" is provided by satellites. Satellite images (familiar to many from Google Earth), capture images in a similar way to a digital camera. The images are made up of pixels and the data captured in each pixel represents the combined reflected light (the colour) of all the land covers that the pixel imaged.
The problem of clouds obscuring satellites' view of the ground is a particular challenge in

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upland areas so we looked at augmenting the optical camera data with satellite radar data. Radar sensors emit a microwave signal that penetrates cloud. The sensors then record the signal that is reflected back to satellite. The strength of the returned signal is a function of topography, surface roughness and the electrical properties of the surface, which are correlated with land cover and land use.

4. Main results:

Overview of land cover mapping in Europe

Most European countries have landcover or habitat mapping programs. An exhaustive study of existing systems found that current standards use a mix of satellite and other sources of remote sensing data; they use state-of-the-art object orientated machine learning classification. The objects are defined from national mapping databases but image segmentation is used to gap fill.

Consensus

A workshop was held to canvas opinion on mapping and reporting land cover change in Ireland. Using the CrowdWise consensus building approach, invited stakeholders voted anonymously to rank different scenarios from their least to most preferred choice.

For enclosed fields in Prime 2 the preferred option was for a minimum mapping area of 0.5ha labelled with the percentage amount of all classes within that area. For unenclosed upland regions the preference was for the region to be broken up to create Prime 2-type polygons of 2-5ha, with all covers mapped as a percentage of the area, and updated at five year intervals.

Mapping landcover with optical satellites

The Suir catchment, a mixture of upland and lowland areas was used to test classification methods and cohesion between enclosed and unenclosed areas. A machine learning algorithm, Random Forrest, has been shown in earlier projects (ILMO project) to be the best approach for Irish land cover mapping. The satellite image was combined with other data and the Prime 2 mapping framework to produce a classified map, at field scale of land cover for the following classes: Water Bodies; Improved Grassland; Semi-Improved Grassland; Heath; Dense Bracken; Raised Bog; Blanket Bog; Broadleaved Woodland; Coniferous Woodland; Scrub/Transitional; Bare Rock; Bare Soil; Built Land; Arable Land.

When compared to field points and independent observations the overall map accuracy was 91%

Introducing RADAR satellites to the classification

Combining RADAR data with the Optical and ancillary data in the Random Forest model in the trial areas in the Comeraghs, Mount Brandan and the Galtees (Figure 1) increased accuracy to 95%. This is large reduction in the error rate from using optical alone.

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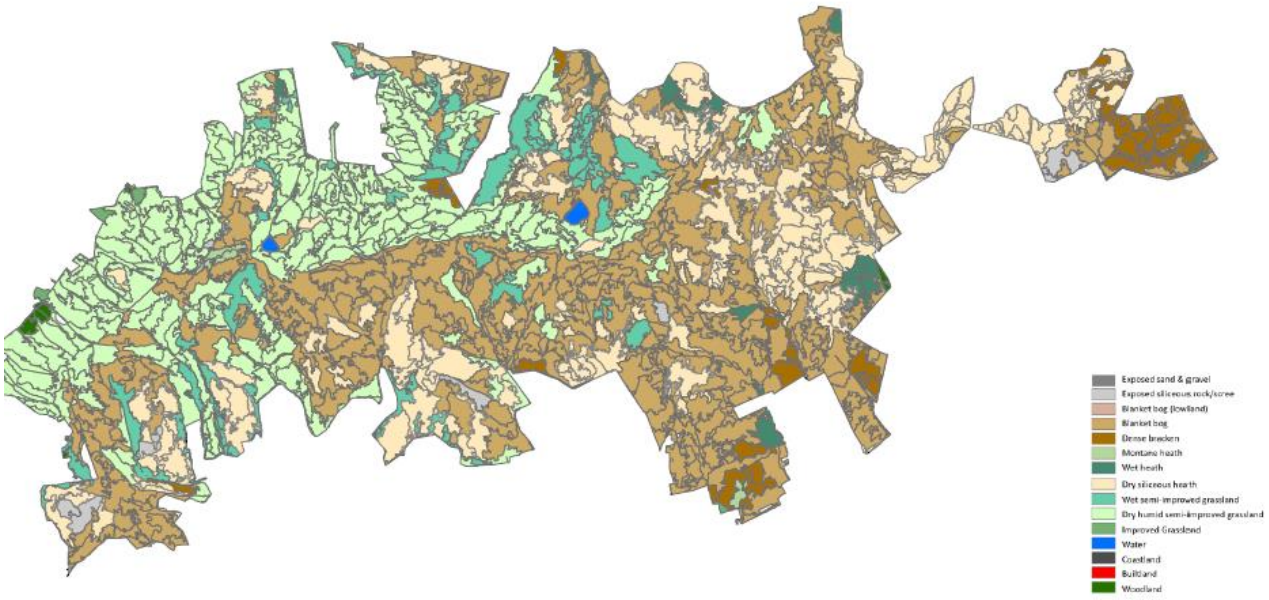

Figure 1: One of the project outputs: a 5 Ha segment landcover map of the Galtee Mountains, 2014.

5. Opportunity/Benefit:

This project demonstrates the utility remote sensing for reliable mapping of important landcover and habitat data that otherwise is not available. Accuracies in the 90-95% range are achievable and satisfactory for most purposes.

The full suite of technical, analytical and data sources are now in place for the development of a national landcover, habitat and land use mapping program.

The only outstanding technical issue to be resolved is the generation of automatic change detection between map iterations (distinguishing between real change and error); which should be included in a future research call.

6. Dissemination:

As well as technical documents below, the TALAM project has been presented at numerous conferences and stakeholder workshops.

A newsletter was produced at the mid point of the project to keep stakeholders informed. A survey was carried out for the 1st year workshop. Material can be found on the project Blog :landmapping.wordpress.com

Main publications:

Raab, C., Barrett, B., Cawkwell, F., Green, S. (2015): Evaluation of multi-temporal and multi-sensor atmospheric correction strategies for land cover accounting and monitoring in Ireland. Remote Sensing Letters, 6.10:784-793.

Popular publications:

Green, S., Cawkwell, F., Barrett, B. (2016) Mapping Irish uplands using satellite, T-research. Vol. 11(3), Autumn 2016

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