Linking Hydro-Geophysics and Remote Sensing Technology for Sustainable Water and Agricultural Catchment Management

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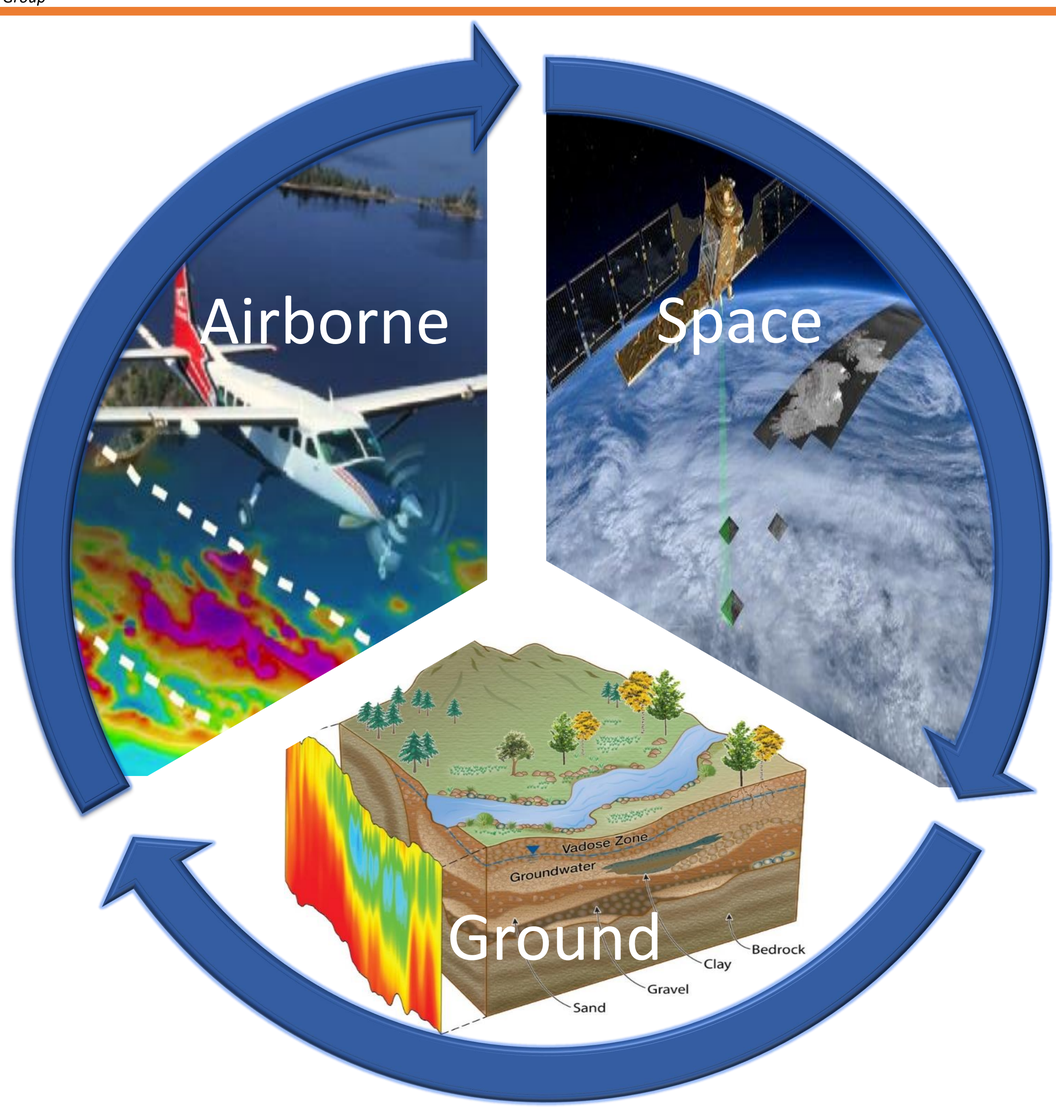
Science Foundation Ireland For what's next
An Roinn Talmhaíochta, Bia agus Mara Department of Agriculture, Food and the Marine

Introduction:

The acquisition of sub-surface data for agricultural purposes is traditionally achieved by in situ point sampling in the top 2m over limited target areas (farm scale ~ km2) and time periods. This approach is inadequate for integrated regional (water catchment ~ 100 km2) scale management strategies which require an understanding of processes varying over decadal time scales in the transition zone (~ 10's m) from surface to bedrock. With global food demand expected to increase by 100% by 2050, there are worldwide concerns that achievement of production targets will be at the expense of water quality.

In order to overcome the limitations of the traditional approach, this research programme will combine airborne and ground geophysics with remote sensing technologies to access hydrogeological and soil structure information on Irish Soils at multiple spatial scales. It will address this problem in the context of providing tools for the sustainable management of agricultural intensification envisioned in Food Harvest 2020 and Food Wise 2025 and considering the EU Habitats and Water Framework Directives (WFD), Clean Air Policy and Soil Thematic Strategies.

The work will use existing ground based geophysical and hydrogeological data from Teagasc Agricultural Catchment Programme (ACP) and Heavy Soil sites co-located ground and airborne electromagnetic data. Neural Networks training and Machine learning approaches will supplement traditional geophysical workflows. Work will then focus on upscaling results from ACP to WFD catchment scale. This upscaling will require modification of traditional satellite remote sensing conceptual frameworks to analyse heterogeneous, multi-temporal data streams.



Research Team and aims


Dr. Eve Daly


Prof. Colin Brown

Long-term aim
Establish a high density, multi-scale observatory for scientific basis of time-dependent process-orientated hydrogeological models and scaling theories for agricultural and environmental management


Dave O'Leary, PhD Researcher

IRISH RESEARCH COUNCIL An Chomhairle um Thaighde in Éirinn

Geophysical remote sensing of surface and subsurface physical properties for sustainable agricultural management.

- Inversion of ground EM data to obtain hydrogeological and soil structure information on Irish Soils?
- Application of neural network and machine learning to obtain material properties of soil layers, horizontally and vertically.
- Can this approach be scaled from field to catchment areas using airborne and satellite remote sensing methods?

?

PhD. Applications being received

VistaMilk

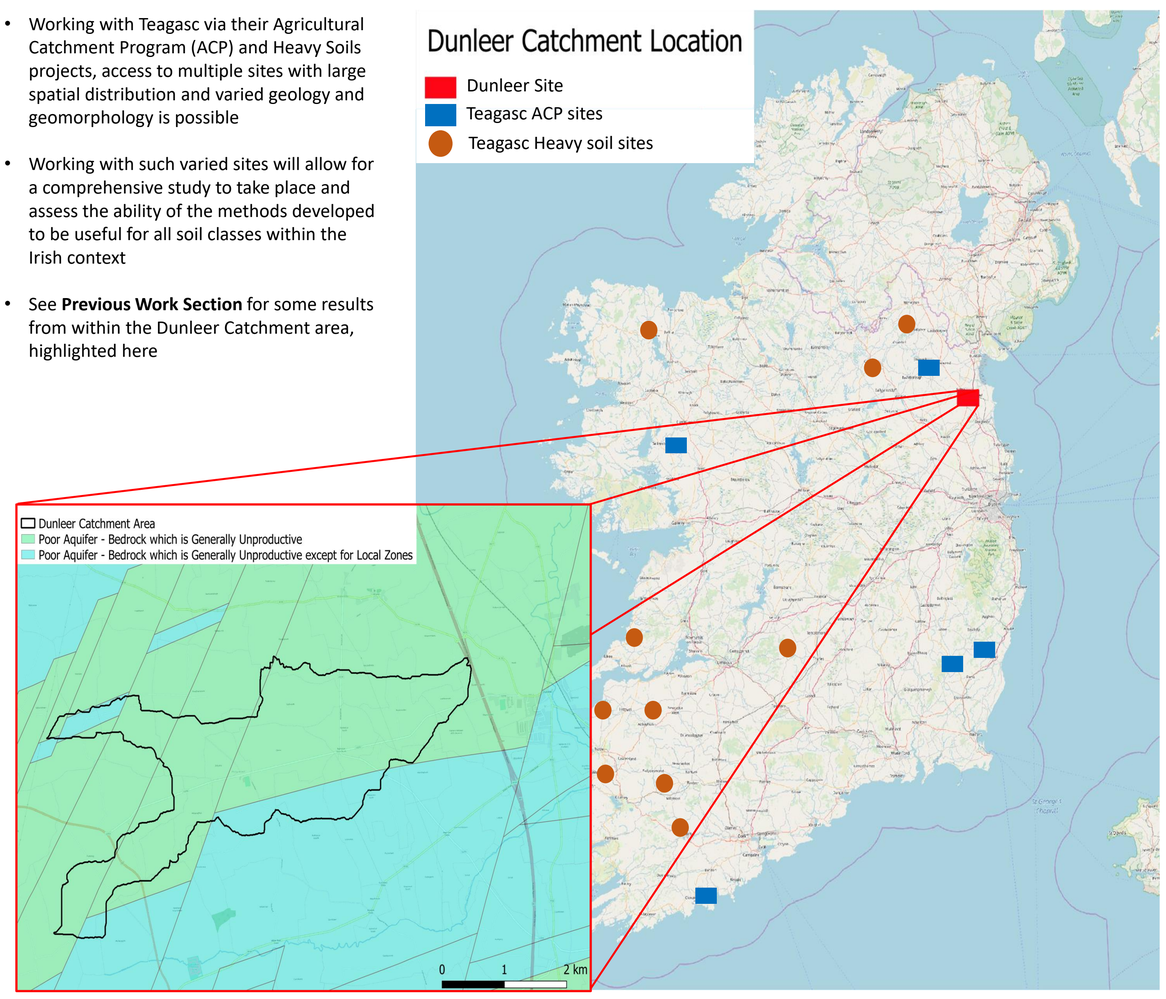
Optimising remote sensing technologies to aid soil characterisation and drainage design and catalogue existing drainage features

- can satellite remote sensing be used to identify existing drainage features at different spatial scales?
- Can machine learning approaches be integrated with satellite data and the Tellus radiometric dataset to improve soil characterisation and identification of drainage status?
- Can the above approaches be linked with ground-based EM surveys to constrain subsurface soil properties?

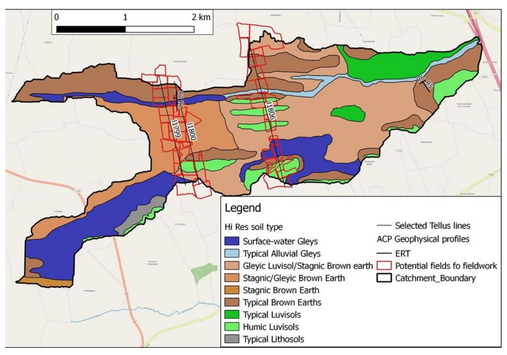
Current Research Status:
- *Poster presentation at IGRM2019*
  - *Workflow for input, QC, Processing and Inversion of large scale Tellus EM Data has been developed*
- *Testing of Principle Component Analysis filtering on Tellus data as per Minsley 2012. Potential paper deliverable*
- *Planning field work in autumn 2019 to gather ground EM and ERT data at Teagasc ACP or Heavy Soil site*

Potential research sites throughout Ireland

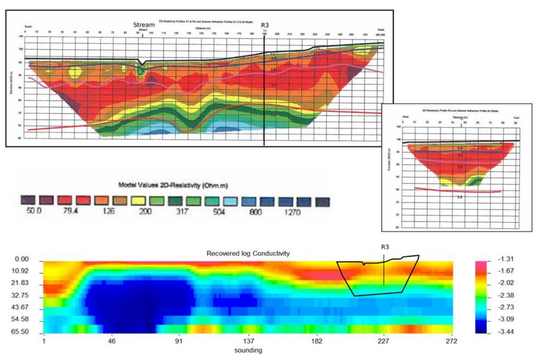
- Working with Teagasc via their Agricultural Catchment Program (ACP) and Heavy Soils projects, access to multiple sites with large spatial distribution and varied geology and geomorphology is possible
- Working with such varied sites will allow for a comprehensive study to take place and assess the ability of the methods developed to be useful for all soil classes within the Irish context
- See **Previous Work Section** for some results from within the Dunleer Catchment area, highlighted here



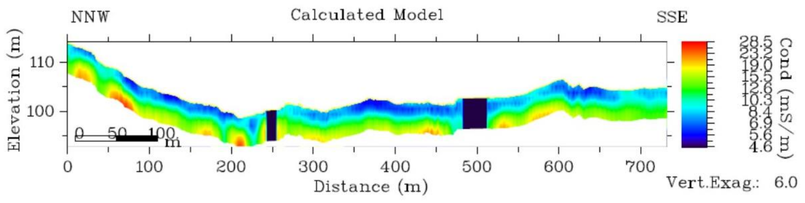
Previous work



Established a test site in Dunleer ACP, Co. Louth

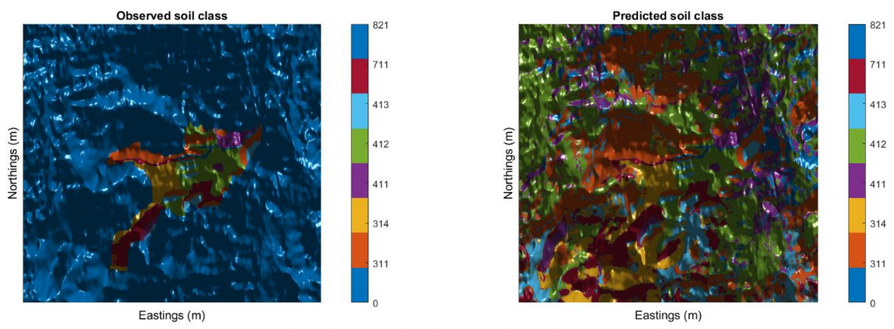


Ground Electrical resistivity and Airborne EM at Dunleer site



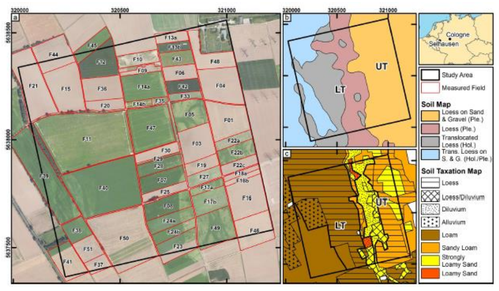
Ground Electro-Magnetic data showing variable depth profiles at Dunleer site

Current work



Neural Networks to predict soil class using Tellus radiometric data and 10m DEM at Dunleer site

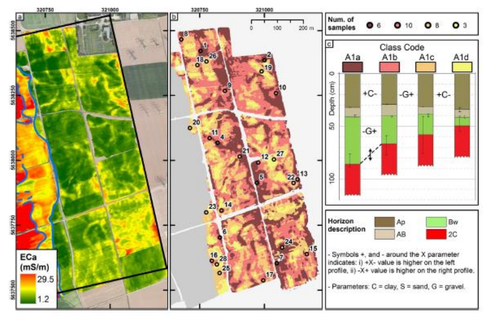
Current cutting edge from literature



This paper shows the framework for PhD 1 and PhD 2 *but* we also have Tellus radiometrics data to work with

Integration of EM (PhD 1), satellite remote sensing (PhD 2)

Large-scale soil mapping using multi-configuration EMI and supervised image classification in Germany Brogi *et al* 2019, *Geoderma*



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Roinn Cumarsáide, Gníomhaithe ar son na hAeráide & Comhshaoil
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