C- and L- band Synthetic Aperture Radar (SAR) for Estimating Spatially Distributed Surface Soil Moisture Content in Southern Ireland

Brian W. Barrett[1] Dr. Ned Dwyer[2] Dr. Padráig Whelan[1]

[1] Dept. of Zoology, Ecology and Plant Science (ZEPS), University College Cork (UCC)
brianbarrett@student.ucc.ie, p.whelan@ucc.ie
[2] Coastal & Marine Resources Centre (CMRC), University College Cork, (UCC), n.dwyer@ucc.ie

1. BACKGROUND

The amount of water stored in the soil is a **key parameter** for the energy and mass fluxes at the land surface, and even though soil only contains a small percentage of the total global water budget, **soil moisture is of fundamental importance** to many meteorological, agricultural and ecological processes. However, despite its importance, widespread and/or continuous measurement of soil moisture is all but nonexistent. **Microwave remote sensing** offers the possibility to quantify and monitor moisture changes over large areas at regular intervals in time.
The theory behind microwave remote sensing of soil moisture is based on the large contrast between the dielectric properties of liquid water (dielectric constant value of ~ 80) and dry soil (~ 4) (wet soil ~ 20), which results in a high dependency of the **complex dielectric constant (ϵ)** on volumetric soil moisture (m_v).

2. RESEARCH OBJECTIVES

This research investigates the sensitivity of radar backscatter to surface soil moisture content using different sensor configurations, and at different crop (barley & potato) phenological stages.

I. Derive the relative changes in soil moisture between different ASAR (Advanced Synthetic Aperture Radar) and PALSAR (Phased Array L-band Synthetic Aperture Radar) acquisitions using a **m u l t i temporal analysis.**

II. Formulate a **semi-empirical inversion model** to simulate and derive absolute soil moisture measurements.

3. STUDY SITE

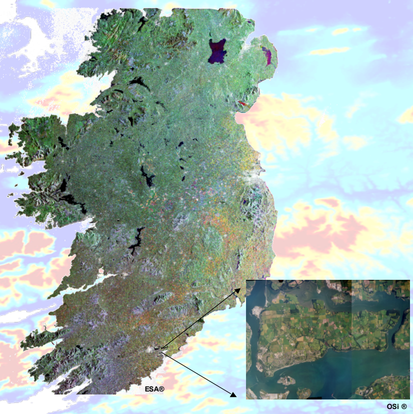
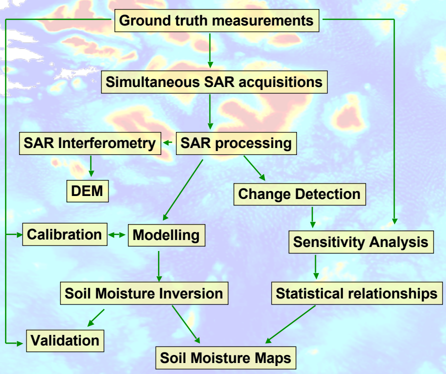


Figure 1: Location of study areas at Cobh Island, Cork, Ireland.

4. METHODOLOGY



5. FINDINGS TO DATE

A wide range of surface soil moisture conditions have been recorded (figure 2) to date along with their respective backscatter derived from the SAR data. At present, the study has concentrated on the multi temporal analysis of which some preliminary results are presented.

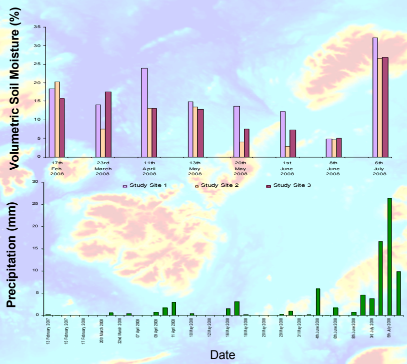


Figure 2: Time-series *in situ* volumetric soil moisture (means) and precipitation data at Cobh, Cork.

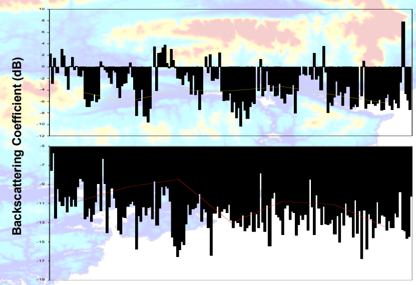


Figure 3: C-band HH polarisation (top) and HV (bottom) backscattering coefficients for study sites.

From figure 4, a weak relationship between the radar backscatter and vol. soil moisture content is evident (HH: r2 0.25, HV: r2 0.38), however incorporating additional information on parameters such as **surface roughness** and **vegetation** and the inclusion of a much longer time series will provide greater understanding and enable a more complete analysis.

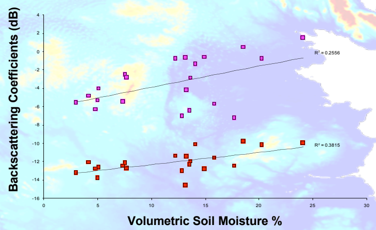


Figure 4. Sensitivity of the HH (pink) and HV (red) C-band Backscatter Coefficients to *In Situ* Soil Moisture Measurements.

Backscatter differences (figure 5) between February and March 2008 are shown with green/ orange depicting changes from high to low backscatter and red/ pink changes from low to high backscatter returns. **Higher backscatter returns relate to a higher moisture content.** When these differences are plotted against the measured soil moisture differences between the two acquisition dates, a much stronger correlation is found, HH: r^2 0.41 and HV: r^2 0.51 respectively. Ongoing research will continue collecting and analysing SAR data with coincident ground measurements and facilitate the formulation of a semi-empirical model.

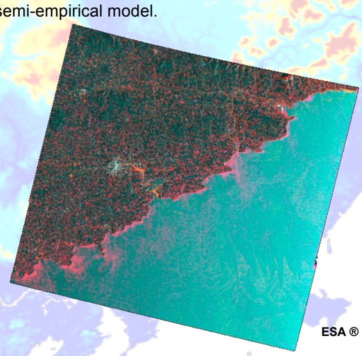


Figure 5: Difference image highlighting backscatter changes in HH polarisation between February and March 2008

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