Using ASAR & ERS-2 to Detect a Moorland Fire Scar in the Peak District National Park, UK
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Introduction

Aim
To explore whether Synthetic-Aperture Radar (SAR) intensity and coherence images can be used to detect a fire scar in a degraded UK peat moorland environment.

Objectives
• Determine the ability of a time series of SAR (ENVISAT ASAR and ERS-2) intensity and coherence images to detect a fire scar
• Improve understanding of how scene variables (soil moisture, vegetation, fire behaviour) affect the SAR fire scar signal
• Investigate the effect of filtering during pre-processing.

Why is Moorland Fire Scar Monitoring Needed?
• Wildfires which burn into blanket peat contribute to climate change by releasing carbon dioxide into the atmosphere. Can permanently damage protected wildlife habitats and discolour drinking water supplies.
• Fire ground location on UK moorlands is poorly recorded. PDNP is unusual in having a fire log (1976 - present) (Fig 1).
• Important for fire responders e.g. PDNP Fire Operations Group (FOG); moorland restoration groups e.g. Moors for the Future (MFF) and other land managers (water companies, the National Trust and gamekeepers).

Study Area
Bleaklow moor, area of blanket peat in the Peak District National Park (PDNP) UK.

Why Use Radar Images?
• Landsat and other optical images detect fire scars but use in the UK is limited by frequent cloud cover.
• SAR can image through cloud and at night.
• SAR successfully used to detect fire scars because image brightness (intensity) relates to surface roughness, terrain and soil/fuel moisture properties which are changed by burning (Bourgeau-Chavez et al., 1997).

Methodology

SAR Pre-processing
• All pre-processing was done in SARscape 4.2. The processing chain for producing the intensity images is shown in Fig 2. Intensity values were calculated in ENVI 4.7.
• Frost, Lee and Degrandi filtering methods have been used during pre-processing to reduce speckle (noise) (Fig 3).
• Frost filter (Fig 3a & 3d), and Lee filter (Fig 3b & 3e) outputs are similar. Fire scar is high intensity (bright) on both, but could be confused with topographic effects.
• Multitemporal Degrandi Filter smoothed speckle more effectively.

Coherence:
• Coherence image measures the degree of correlation between two SAR images, acquired at different times. Produced during interferometric SAR (InSAR) pre-processing, using the phase portion of the radar signal. Measured on a scale of 0 - 1 (Rykhus and Lu, 2007).
  1 = High coherence (temporal correlation, no change on a fire scar in a peat moorland environment)
  0 = No coherence (no correlation, temporal decorrelation, significant change on the ground)

Four InSAR pairs processed:
• 1 before the fire (Fig 7a)
• 1 before and after the fire (Fig 7b)
• 2 after the fire (Fig 7c/d)

SAR Intensity Results & Analysis

Expect image pair before and after the fire to show low coherence due to biomass loss after the fire. A post fire pair expected to show high coherence within the fire scar prior to recovery of vegetation.

Land Cover: Data obtained from CORINE land cover data; and intensity/coherence SAR images acquired from two images acquired after the fire (19/04/03 – 24/05/03).
• Also greatest variation between land cover classes inside the fire scar, strong increase at the eastern end on peat bog, where already exposed peat from older fire scars (Fig 7d).
• Outside the fire scar, coherence decreased for all except natural grassland, probably due to seasonal change in vegetation (Fig 7d).
• Pair 4 (Fig 7d), six and ten days post-fire, shows overall decrease in coherence for all classes. Illustrates an overall decrease in coherence for all classes. This is likely due to temporal decorrelation and also an initial high baseline of 64 for this InSAR pair. It is also during this time that reseeding began on the east side of the fire scar which would increase temporal decorrelation.

Conclusion & Future Work

A large fire scar in a degraded moorland environment can be detected using SAR intensity and coherence.
• The occurrence of rainfall is a critical environmental variable affecting the radar intensity signal.
• Within the fire scar, peat bog gave the highest intensity return probably due to its high sensitivity to soil moisture.
• Highest coherence values within the fire scar were obtained from InSAR Pair 3 (Fig 7c) for the two images acquired shortly after the fire, probably due to a low baseline of 10 and this result indicates low temporal decorrelation between 19/04/03 – 24/05/03.
• Results are sensitive to filtering methods applied during pre-processing.
• Further investigation is required for fire scars of different sizes, on different land cover types, and critically, with different preceding and post-fire rainfall patterns. Also sensitivity to SAR polarisation and frequency.

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References


