Geophysical Research Abstracts
Vol. 15, EGU2013-**PREVIEW**, 2013
EGU General Assembly 2013

Damage evaluation for crops exposed to a simulated leakage of geologically stored CO_2 using hyperspectral imaging technology

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Facilities for the geological storage of carbon dioxide (CO_2) as part of carbon capture and storage (CCS) schemes will be designed to prevent any leakage from the defined 'storage complex'. However, even in the case of such a low probability risk, precautionary principle requires that surfaces at risk be thoroughly and durably monitored to detect a leak, were it to happen. Among all proposed monitoring methods, only hyperspectral imaging of vegetation stress response allows one to scan large areas with a full spectral third dimension., Until now however, only a handful of studies have been carried out on using this novel technology The aim of the present communication was to characterize the impacts that a simulated CO_2 leaks might have on the hyperspectral signature of a Norwegian oats crop.

In order to test the effects of different intensity of leakage, a CO_2 exposure field experiment was designed to create a longitudinal CO_2 gradient. For this purpose a gas supply pipe was inserted at one extremity of a 6m by 3m experimental plot at the base of a 45 cm thick layer of sand buried 40 cm below the surface under a silt loam plow layer. CO_2 was then injected at a rate of 2l.min-1 just after oats emergence, end of June, and continued until harvest, end of August. To facilitate the characterization of the simulated leaking zone the gas used for injection was produced from natural gas and had a δ13C of -46‰Ṡubsequently soil CO_2 fluxes and isotopic signature were recorded at the surface following a (60 x 60 cm) grid sampling pattern.
Hyperspectral images of the experimental plot were taken at different dates during the gassing period using a camera from SPECIM with 800 spectral bands, covering the wavelength range 400 – 1000 nm. The change of reflectance spectra were characterized with time within the plot via the computation of various hyperspectral vegetation indices for small discretized spatial unit (i.e. 10 cm by 10 cm square).

The results showed that plant health and hyperspectral signature were closely related to the leaking pattern.