British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our changing Earth

Monitoring ecosystem impacts of CO_2 storage – the RISCS project

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and the RISCS project team

SEVENTH FRAMEWORK PROGRAMME

IEA GHG 6th Monitoring Network Meeting, Natchez, 6-8th May 2010

Research into **I**mpacts and **S**afety in **C**O_2 **S**torage

- Significant leakage from CO_2 storage is not expected
- If it occurred there could be adverse environmental effects
- These effects are not well constrained

RISCS aims to carry out research on impacts arising from known CO_2 fluxes (observed and modelled)

- In both marine and terrestrial environments
- Through experiments and natural field observations

Project overview

RISCS will provide information to underpin

- Evaluation of safety of storage sites
- Environmental Impact Assessments
- Safe design of sites to minimise impacts
- Design of near surface monitoring strategies
- Refining of storage licence applications/conditions
- Frameworks to communicate safety of storage

Ultimate output is ‘Guide for Impact Assessment’

Project overview

- **4 year project**, fully funded, started January 2010
- **24 participants** (UK, Greece, Netherlands, Italy, Norway, Sweden, France, Germany) + Australia, Canada, USA
- **6 industrial** (Enel, Statoil, Vattenfall, EoN, PPC, RWE) providing funding (c €200k each), research input, advice
- **4 non-European** (CO_2CRC & Montana State, Regina, Stanford universities) in advisory role
- **1 NGO** (ZERO)
- **CO_2GeoNet** (Primarily represented by NIVA, BRGM in addition to 5 participants)
- **IEA-GHG** – advice and help with dissemination

Project organisation

- WP1 **Description of reference environments and scenarios**
- WP2 **Assessing impacts in marine environments**
- WP3 **Assessing impacts in terrestrial environments**
- WP4 **Assessing impacts - numerical simulations**
- WP5 Integration and dissemination
- WP6 Coordination/management

Experiments and field observations

WP1 Description of reference environments and scenarios

- Develop a comprehensive set of credible CO_2 impact scenarios for varied near-surface reference environments
- The scenario analysis process will explore:
  - CCS systems main features, events & processes (FEPs)
  - How CCS systems are likely to evolve with time
  - Potential failure/leakage mechanisms
  - Potential human/ecological impact mechanisms
- The scenarios will be a basis for the experiments, field studies and models investigating impacts
- The overall purpose of the scenarios is to provide a sound basis for the regulation and monitoring of CO_2 storage sites.

WP2 Assessing impacts in marine environments

Field observations

Panarea field site, Italy

Experiments in artificial enclosures

<10 L

1000 L

4500 L

+ Benthic chamber lander

WP2.1 Experiments in artificial enclosures

- Response & recovery of individual species
  - Growth, survival, reproduction
- Response & recovery of benthic communities
  - Microbial, meiofauna and macrofauna

  Including:
  - Speed and scale of impacts
  - Speed of lateral recolonisation
  - Speed of larval recruitment

- **Benthic chamber** – 3 exposure experiments at 3 exposure rates in 400m water for 10 days (in Norway)

WP2.1 Experiments in artificial enclosures

Taxa
Crustaceans
Mollusks
Polychaetes
Plankton community
Micro-organisms
Macro-meiofauna

Chemical/physical parameters
pH
Temperature
Salinity
Dissolved oxygen
Nutrients
DOC
DIC
Alkalinity
Pressure
Nutrient fluxes
Mixing

Biological parameters
Haemolymphe parameters
Growth
Survival
Reproduction

WP2.2 Field observations

- At Panarea, southern Italy, CO_2 is naturally leaking to the water column (~20 m water depth)
- Diffuse and localised leaks, gas vents with a range of flow intensity
- To address: system complexity, **spatial-temporal variability**
- To extrapolate the experiments into **real-world** situations

WP2.2 Field observations

An integrated study will be performed:

- **Chemical** – Conductivity-temperature-depth (CTD) transects, water sampling (Niskin bottle and multi-parameter probe) & continuous monitoring station
- **Biological** – virus & prokaryote abundances, prokaryote community structure, in-situ benthic flux measurements
- **Physical** – Acoustic Doppler Current Profiler (ADCP) to determine circulation, vertical and horizontal structure components of the current during seasonal sampling

WP3 Assessing impacts in terrestrial environments

Field experiments

Northern Europe

- Norwegian experiments
- UK (ASGARD) experiments

Field observations

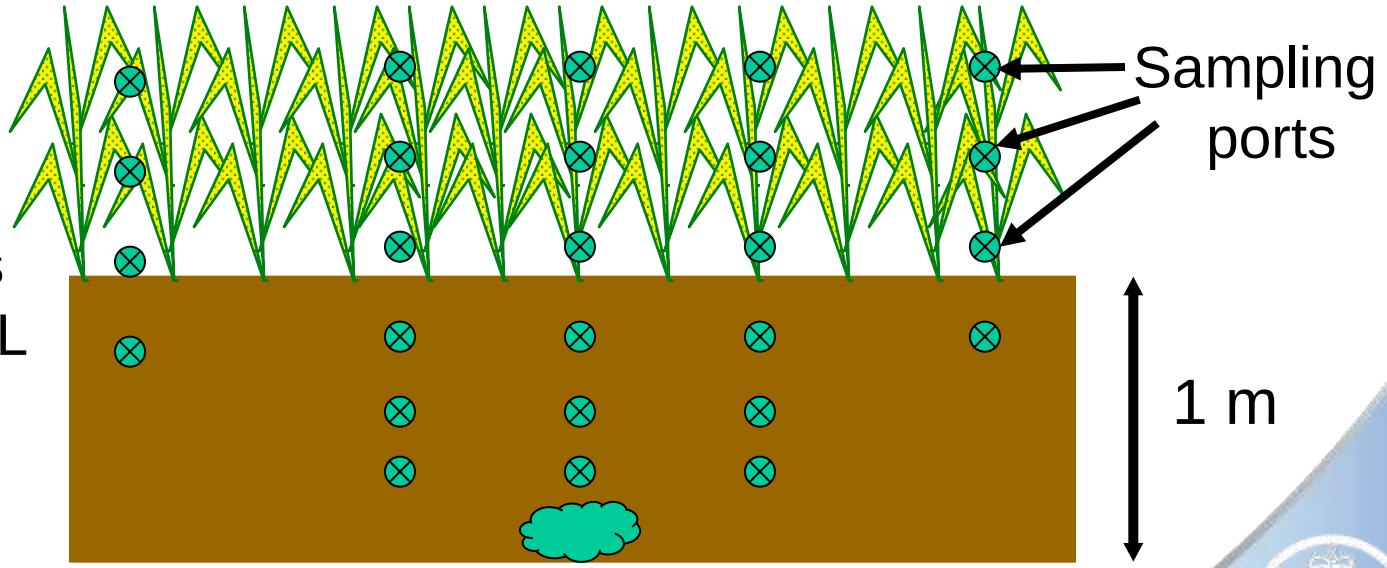
Southern Europe

- Italy, Greece, France

WP3.1 Norwegian experiments

- **Effects (greenhouse experiments)**

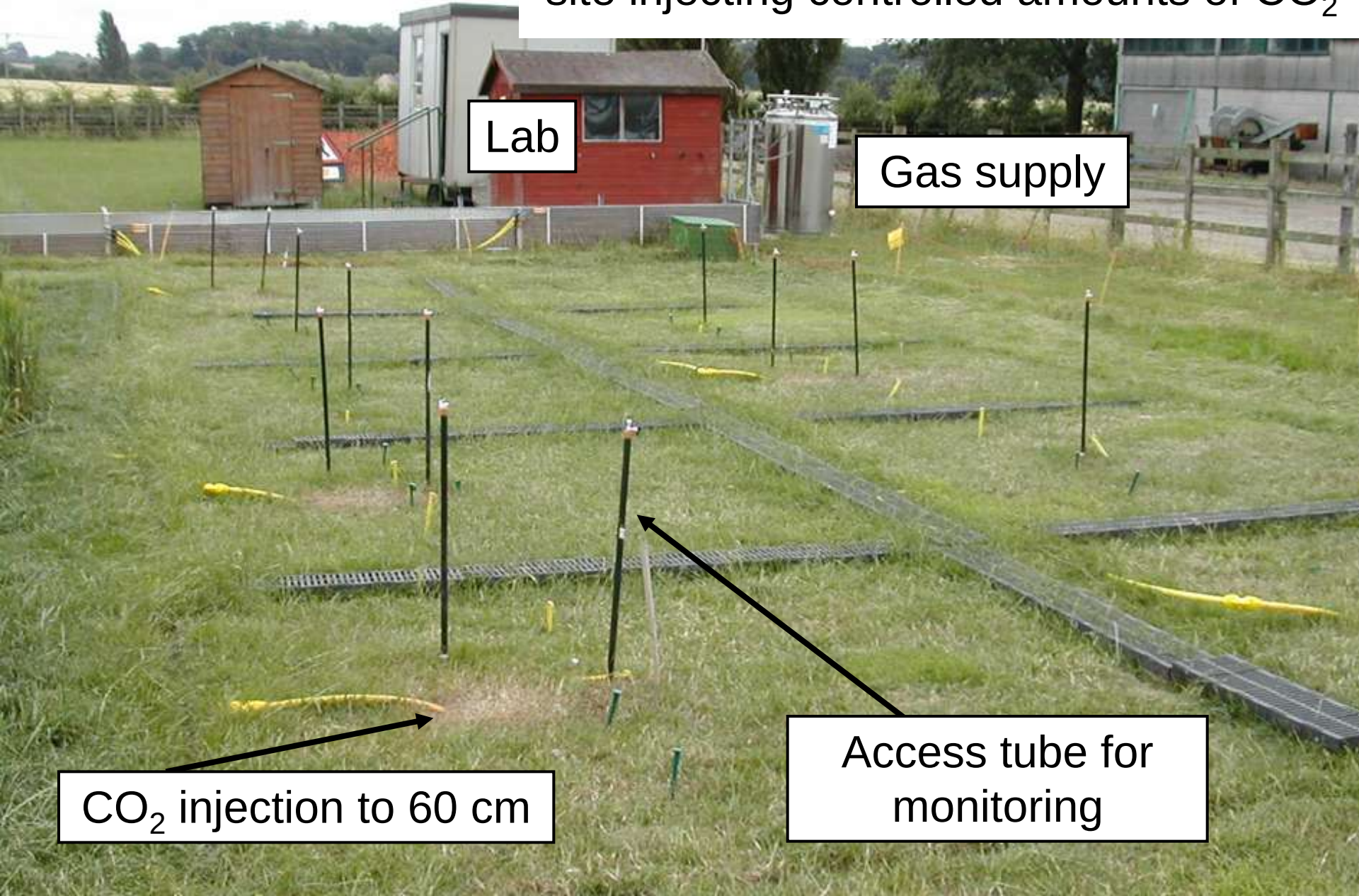
- **Exposure (simulated CO_2 leak)**



Measurements with $^{13}C/^{12}C$ TDL (tunable diode laser spectrometer)

WP3.2 ASGARD

University of Nottingham experimental site injecting controlled amounts of CO_2



WP3.2 ASGARD

- Test detection techniques
  - Remote sensing
  - Isotope analysis
  - Continuous monitoring
- Monitor changes in plant and soil conditions (chemistry, microbiology)
- Test sensitivity to soil and plant types and gas concentration (impact thresholds, effects on roots, ecosystem recovery)

WP3.3 Naturally leaking sites in southern Europe

- Florina well site, Latera, San Vittorino & Montmiral sites
- Variety of flux rates, time scales and gas compositions
- Impact of leaking gas on:
  - **Vegetation** (spatially and through time)
  - **Potable groundwater quality** (water origin, mixing and water-rock-gas interaction)
- Impact of using CO_2-impacted groundwater for crop irrigation

WP4 Assessing impacts – numerical simulations

- **Synthesise** information from WPs 1, 2 & 3
- Quantify CO_2 **transport** onshore and offshore in space/time and the associated chemical **perturbation**
- Develop a:
  - **Marine systems model** describing the key biogeochemical and ecological components relevant to CO_2 and its impacts in shallow sediment layer and overlying water column *(varying depth, mixing, temperatures and fauna)*
  - **Terrestrial systems model** representing the important processes in the transport of CO_2 to and in the near-surface terrestrial environment, and its impacts *(e.g. pH evolution and groundwater quality)*

Guide for Impact Assessment

Inform key stakeholder groups on specific issues:

- What to consider when appraising potential impacts in the event of leakage from a storage site
- How to evaluate the potential impacts of storage project development: design stage, construction, operation, post-injection and to enable transfer of site liability to the competent authority
- Options for directly assessing the potential scales (temporal and aerial, realistic leakage ranges (fluxes, masses)) and ecosystem responses
- Options for identifying, predicting and verifying the nature of impacts

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