Characterisation of European CO_2 storage

What is the relevance of baseline data for site characterisation?

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Regulatory requirements for monitoring

- **EC Storage Directive (monitoring plan)**
  - **Monitoring throughout the project lifetime**
  - **Member state authority controls the operators monitoring activity**
- **Monitoring objectives**
  - **Site performance (predicted *vs*. observed behaviour)**
  - **Leakage detection**
  - **Detection of significant irregularities (pressure -, plume development)**
  - **Adverse environmental impacts**
  - **Assists in deployment of any corrective measure**
  - **Verify long-term storage stability and permanent containment**
  - **Update site performance assessment**
  - **Update risk assessment for the site every 5 years**

Monitoring plan

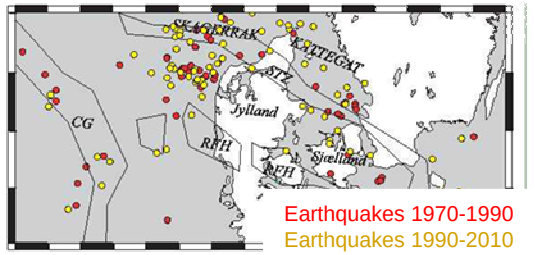
- **Risk driven and site specific**
  - **Site specific risk assessment to guide a meaningful monitoring plan**
  - **Onshore and offshore sites have different challenges for choice and deployment of monitoring techniques**
  - **Monitoring plan deployed at all the main stages of a storage project**
    - **Baseline, operational and post-injection stages**

- **Dynamic document**
  - **Operator must update monitoring plan and strategy if any irregularities are discovered**
  - **Update 3D models – monitoring surveys tied to appropriate modelling procedures and interpretations**

Monitoring plan – Vedsted, onshore DK

Baseline surveys

- **Objectives for baseline data**
  - **Pre-injection dataset for all proposed monitoring techniques**
  - **Pre-injection dataset for any operational induced irregularities**

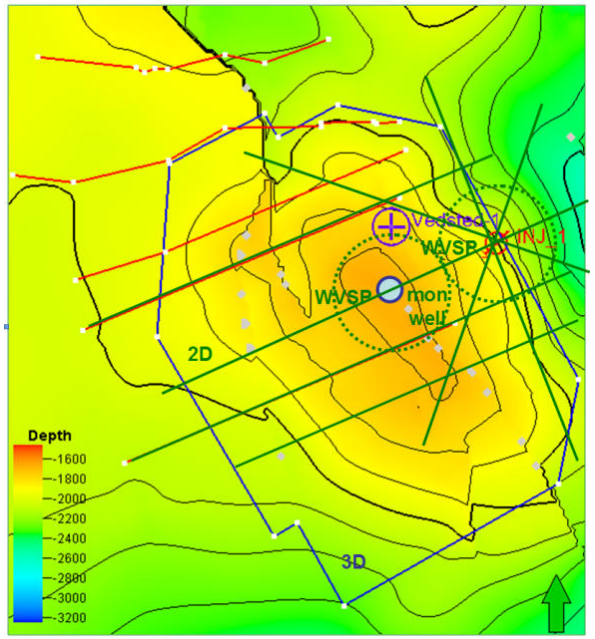


- **Challenges for baseline data**
  - **All natural variability must be captured**
    - **Background or natural soil gas fluxes, seasonal variation, weather conditions, non-operational seismicity ect.**

- **Benefits from baseline data for site characterisation**
  - **Comprehensive data acquisition and interpretation program**
  - **Initialisation and calibration of 3D modelling**

Baseline survey – Vedsted, onshore DK

- **Proposed baseline surveys**
  - **For detection of plume migration and pressure development different geophysical monitoring tools are planned for**
    - **Time-lapse 3D and 2D surface seismics, 3D VSP together with downhole pressure and temperature monitoring**
  - **Interpretation of baseline dataset(s) strengthens the initial site characterisation**



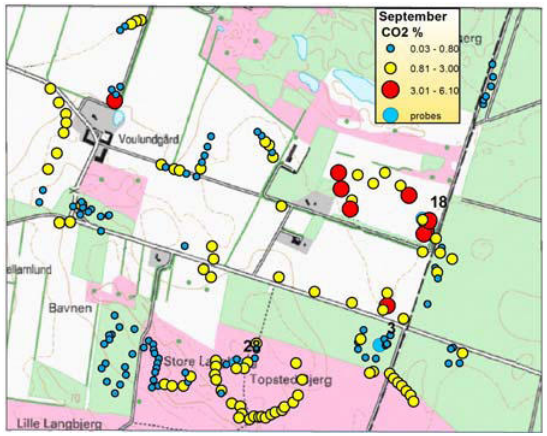
Map showing the Vedsted structure with the injection and monitoring wells and layout of baseline seismic surveys: VSPs (green dotted circles), 2D seismic baseline data (green), legacy data (red), 3D seismic baseline (large blue polygon).

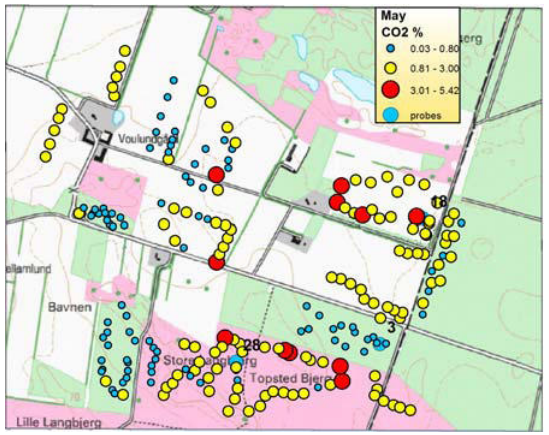
Baseline survey – Vedsted, onshore DK

- **Near-surface gas baseline survey for dry-run appl.**
  - **A near-surface gas geochemistry research survey was conducted at the Voulund agricultural research site**
    - **Vedsted site not available, but Voulund used as an analogue site (climate, shallow geology, topography, land-use etc.)**
  - **Definition of natural baseline values for soil gasses**
    - **CO_2, O_2, N_2, CH_4, C_2H_4 and He**
  - **Definition of range of natural baseline values**
    - **Influence from land-use and climate seasonality on the temporal and spatial variability**

Baseline survey – Vedsted, onshore DK

- **Two monitoring campaigns**
  - **University of Rome responsible for field measurements**
  - **Approx. 175 data points were sampled in the period 7 – 14 September 2011**
  - **Approx. 200 data point were sampled in the period 15 – 22 May 2012.**
  - **Approx. sample density of 100 samples / Km^2**
  - **Soil gas analysis and gas flux measurements**



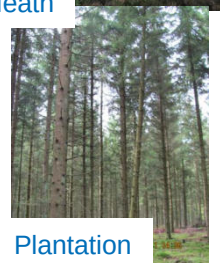


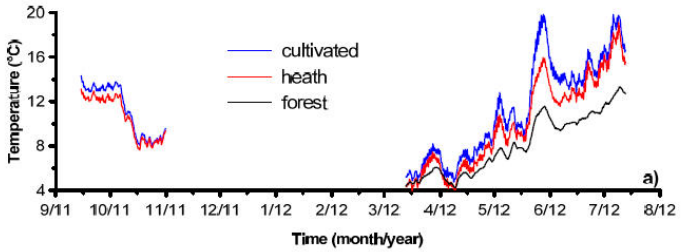
Results and recommendations

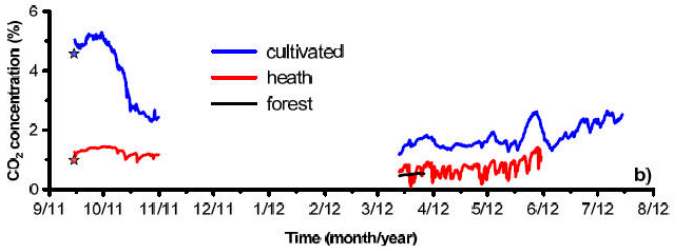
- **Initial study should map the area in terms of land-use, topography, surface geology, soil type, water content and drainage pattern**
- **Study area should encompass the final and stable footprint of the CO_2 plume estimated from dynamic modelling**
- **Sampling density > 20 / km^2**
- **Sampling season and timing during the baseline phase; one sampling campaign during each of the four seasons as a minimum – preferably a repeat campaign for year-on-year variability observation**


Cultivated


Heath


Plantation





Public communication note

Data should be open to the public and actively disseminated, both during the baseline activities to inform locals regarding what types of values are typically encountered in that area and also during the monitoring phase to support transparency and to illustrate the safety of the storage system. This could take the form of both a web page and distributed brochures. In this manner these types of surveys would not only provide valuable monitoring data, but would also be an important, easy-to-understand platform for dialogue with the local stakeholders, both pre- and during injection.

Summary

- **Baseline data provide additional data for the site characterisation**
- **3D modelling can be optimised by (repeat) 3D seismic acquisition**
- **Baseline data provide input for modelling initialisation**
- **Natural background fluxes can be determined for proper detection of future irregularities**
- **Platform for communication**
- **Variability in data can be described and validated**
- **So; baseline data acquisition is absolutely worth the effort**