



Characterisation of European CO₂ storage

Storage feasibility workflow
Rob Arts

Kick-off meeting
Stakeholder Workshop
September 24, 2013



Site Characterisation

- **Multidisciplinary approach**
 - Geology, geophysics, geochemistry, geomechanics, ...
- **Many links between expertises**
 - Example: reservoir engineering & geomechanics, through pressure
 - Storage risks often fully defined only by combining multiple expertise areas
 - Storage Directive aspects also addressed by combining results from several disciplines
- **Clarify links**
 - To render site characterisation work more efficient and effective



SiteChar workflow

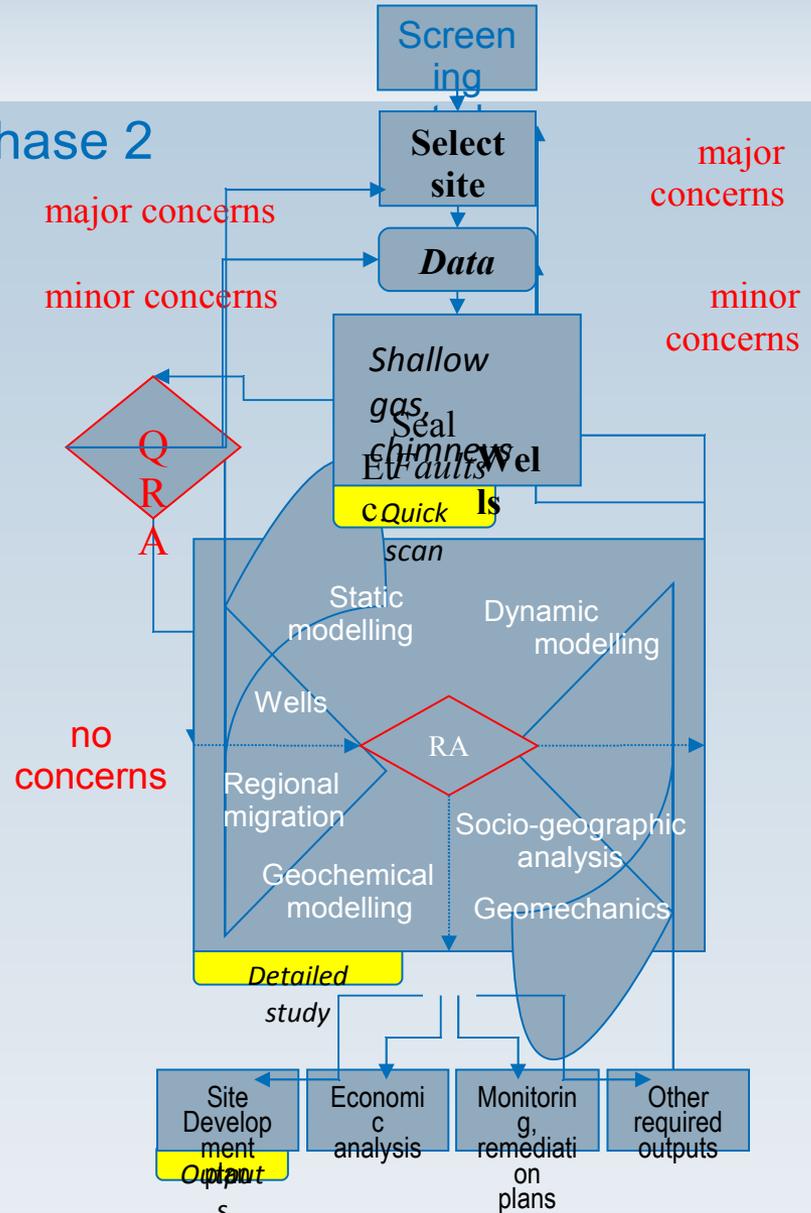
- **Risk driven**
 - **Site characterisation is about understanding the risks of storing CO₂ at specific site**
 - **Risks mitigated through**
 - **Injection strategy**
 - **Site design**
 - **Monitoring plan**
 - **Contingency (corrective) measures plan**
 - **Residual risks**
 - **After all mitigation measures**
 - **Thresholds defined by operator, competent authority**
 - **Key Performance Indicators**
 - **Monitored during operation**
 - **Trigger additional monitoring, corrective measures**

Site characterisation study

- **Site characterisation workflow**
 - Aligned with EU Storage Directive
 - Tested and improved in five site studies in the SiteChar project

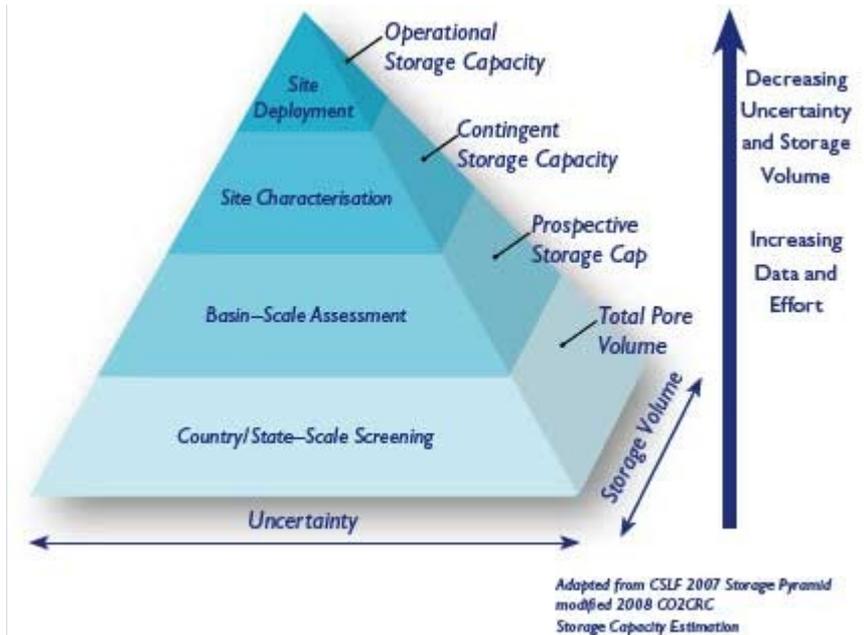
Phase 1

Phase 2



Workflow elements: screening study

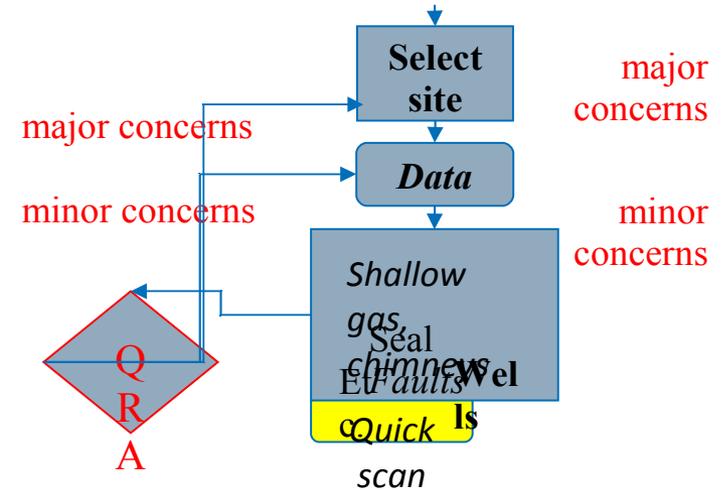
- **Regional screening study**
 - High-level screening of potential sites
 - Limited site data
 - Criteria: (example list)
 - Total storage capacity
 - Injection rate
 - Distance
 - Availability
 - Surface use



Workflow elements: detailed study

■ Preparation

1. **Collect all available data**
2. **Quick analysis of data**
 - **Experts to define risks and potential show stoppers**
3. **Qualitative risk analysis**
 - **All expertises**
 - **Not necessarily integrated yet**
 - **Input: results from quick analysis**
 - **Output: first version of ranked risk matrix**



| Activity/Task | Risks | | | |
|---|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|-------|-----|------|-----|
| | High | Low | | |
| 1. Grant Administration | High | Low | High | Low |
| 2. Executive and Administrative | High | Low | High | Low |
| 3. Public Policy and Information | High | Low | High | Low |
| 4. Information Technology | High | Low | High | Low |
| 5. Planning, Evaluating and Reporting | High | Low | High | Low |
| 6. Project Development | High | Low | High | Low |
| 7. Designated State Agency (DSA) Operational Relationship | High | Low | High | Low |
| 8. Council Support | High | Low | High | Low |
| 9. Administrative Support Finance & Accounting, Human Resources, Purchasing | High | Low | High | Low |

Example of ranked risk matrix

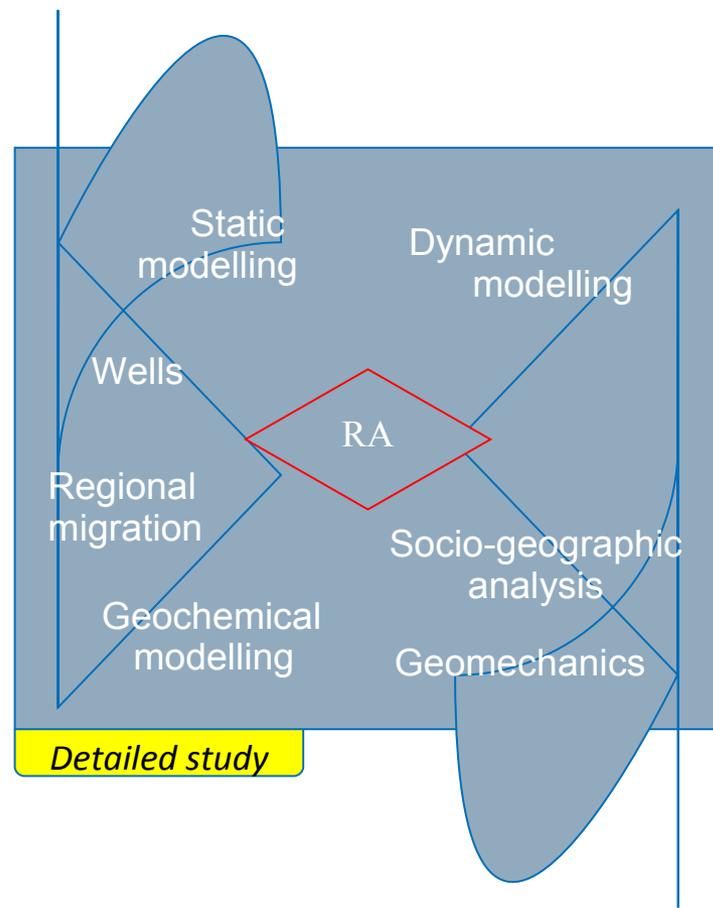
Workflow elements: detailed study

■ Detailed study

- Static model building, geomechanical analysis, dynamic (injection and flow) modelling, etc.
- Focus is on most important risks
- Links / interfaces and feedback loops between disciplines
- Work towards permit deliverables

- *Site characterisation is not a study of site geology, of reservoir behaviour, of large-scale flow...*

- *Site characterisation is a study to produce input for a permit application.*



Workflow elements: detailed study

- **Risk matrix focuses the site characterisation work**

- **Highest risks most emphasis**
 - Define severity and probability more precisely
 - Risk mitigation options
 - E.g., injection scenario definition
- **Continuous risk assessment**
 - New risks may be found

Probability	Very high	0	0	0	0	0
	High	0	2	4	2	0
	Medium	0	4	18	8	0
	Low	0	3	20	13	0
	Very low	0	0	4	1	0
		Very low	Low	Medium	High	Very high
Severity						

Example of risk matrix



Example of links between areas of expertise

- **Injection, plume migration***
 - Pressure limits due to reservoir and cap rock strength; fault reactivation (*geomechanics*)
 - Near-well pressures, CO₂ migration and pressure distribution in reservoir, number and location of wells required to reach target rate (*reservoir engineering*)
 - Location of legacy wells and risk when in contact with CO₂, location of current production wells (*well integrity*)
 - Impact of potential large-scale migration if CO₂ plume migrates out of reservoir (*migration analysis*)
 - History match leads to updates to static model (*reservoir engineering*)
- **Iterative approach is required to find optimum solution**

* List is of course incomplete!

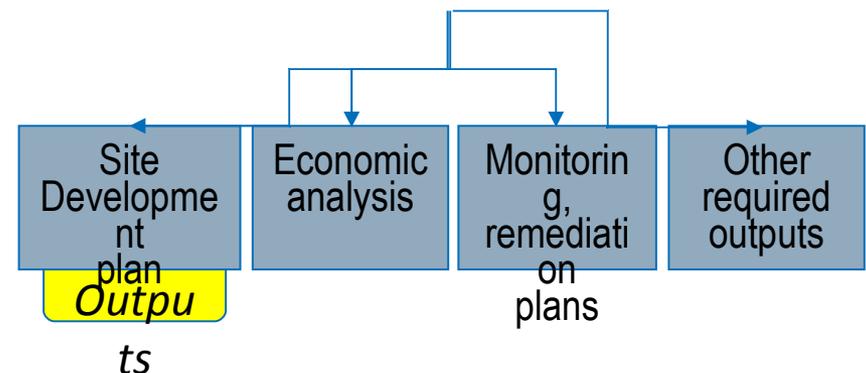


Workflow elements: detailed study

- **Risk assessment: a continuous process**
 - Improved understanding of risks through detailed study
 - Identification of new risks
 - Mitigation of risks through site design and monitoring
- **Close, regular contact with Competent Authority**
 - Improve CA's understanding of site and the CCS project
 - Ensure site performance meets CA standards
 - Important especially for early CCS projects

Workflow elements: detailed study

- **When all risks sufficiently characterised**
 - **Use results to write permit application**
 - **Site development plan**
 - **Monitoring plan**
 - **Corrective measures plan**
 - **Environmental impact assessment (*outside focus of SiteChar*)**
 - **Economic analysis (cost of project)**





Conclusion

- **SiteChar workflow**
 - Describes tasks, flow of work to address EU Storage Directive
 - Highlights dependencies among various disciplines in site characterisation team
- **Key findings**
 - Site characterisation is risk based; it is of key importance to continuously update the risk matrix during the site characterisation
 - Regular contact with the competent authority is strongly recommended
 - The characterisation team should be aware of the links between the areas of expertise and the iterative nature of the work

SiteChar Workflow



- The workflow is available at <http://www.sitechar-co2.eu/FileDownload.aspx?IdFile=605&From=Publicat>

**EUROPEAN COMMISSION
DG RESEARCH**
SEVENTH FRAMEWORK PROGRAMME
THEME 5 - Energy
ENERGY.2010.5.2-1-CCS - storage site characterisation
Collaborative Project- GA No. 256705

ite char
SiteChar
Characterisation of European CO₂ storage
Deliverable N° D1.4
Site characterisation workflow

Deliverable No.	SiteChar D1.4
Deliverable Title	Site characterisation workflow
Author	Project
Classification level	TSO
Lead Beneficiary	Fritz Heide (THO), Florence Espinasse-Jambou (IFPEN), Oliver Vinkler (IFPEN), Vanessa Vohsi (OGS), Marcell Höpner (THO), Cori Roloff (THO), Axel Kockweiser (THO), Arie (THO), Gert Rietveld (THO), Axel Kockweiser (THO), Lubbe (GRIFF), Susanne Brunsing (E.ON), Christian Heide (OGS), Anne Barthelemy (IFPEN), Annie Baron (IFPEN), Rubea Dabbe (E.ON)
Date	July 2012

Document No. SiteChar D1.4
Issue date July 2012
Classification level TSO
Page 1071

Document No. SiteChar D1.4
Issue date July 2012
Classification level TSO
Page 1071

Document No. SiteChar D1.4
Issue date July 2012
Classification level TSO
Page 1071