

# Risk Assessment in CCS

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# Outline

- What is Risk and Risk Assessment?
- Key risks in CCS
- Tools of Risk Assessment
- Key Challenges to Risk Assessment
- Conclusions



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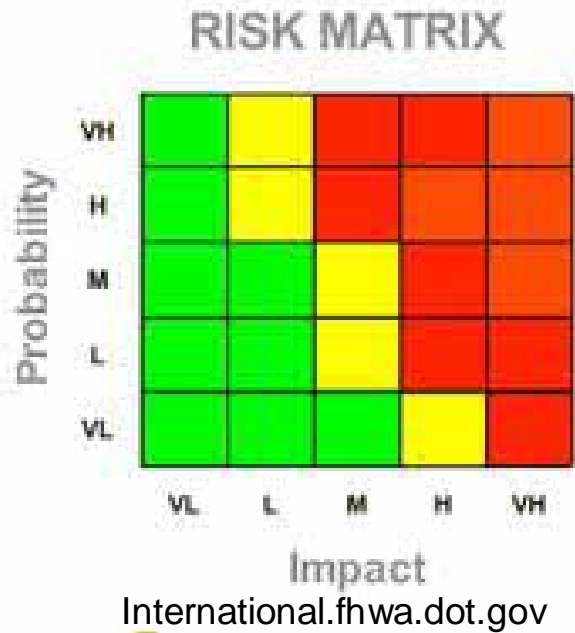




# What is Risk?

**Risk** is the potential that a chosen action or activity (including the choice of inaction) will lead to a loss (an undesirable outcome)(<http://en.wikipedia.org/wiki/Risk>).

**Risk = probability x consequence**



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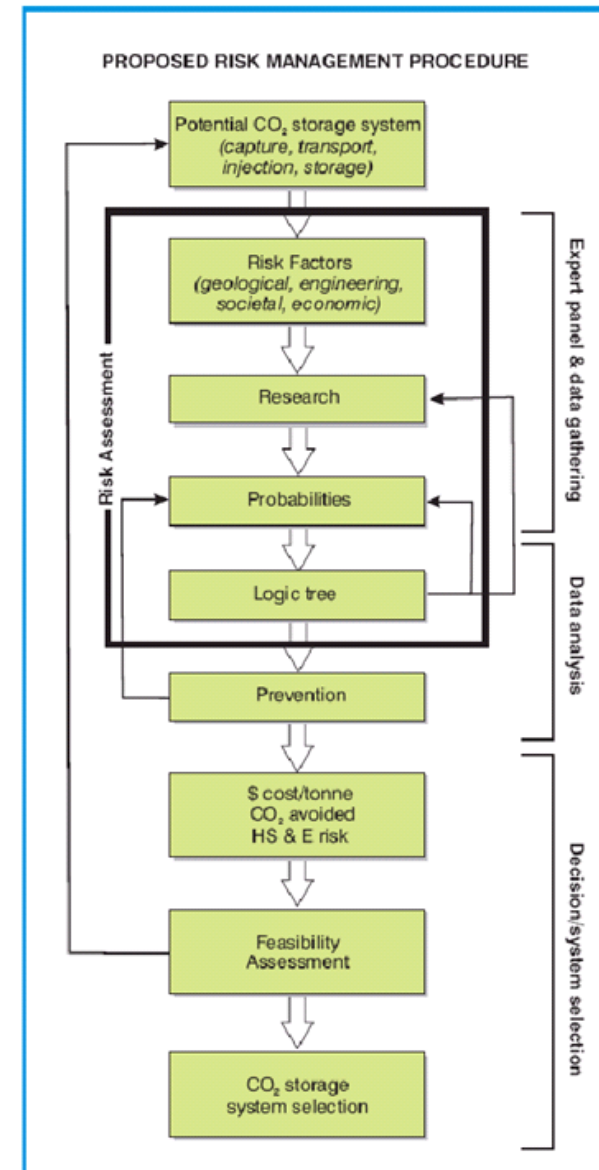
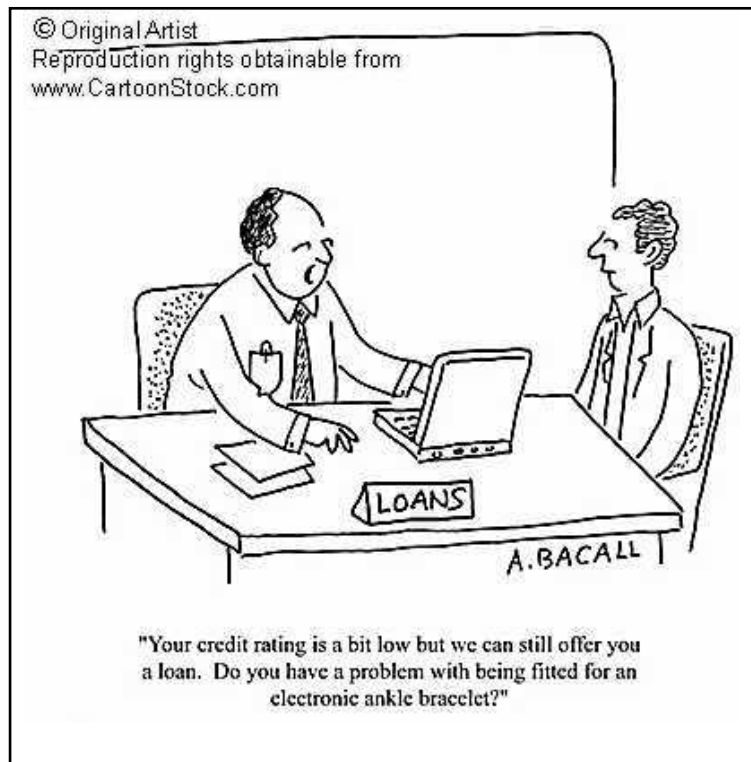


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# What is Risk Assessment?

- **Risk Analysis:** systematic procedure to understand and deduce the levels of risk. Three components: Risk Assessment; Risk Management; Risk Communication.



# What is Risk Assessment?



•**Risk Assessment:** a process to calculate the risk to a given target organism, system or population including the identification of uncertainties.

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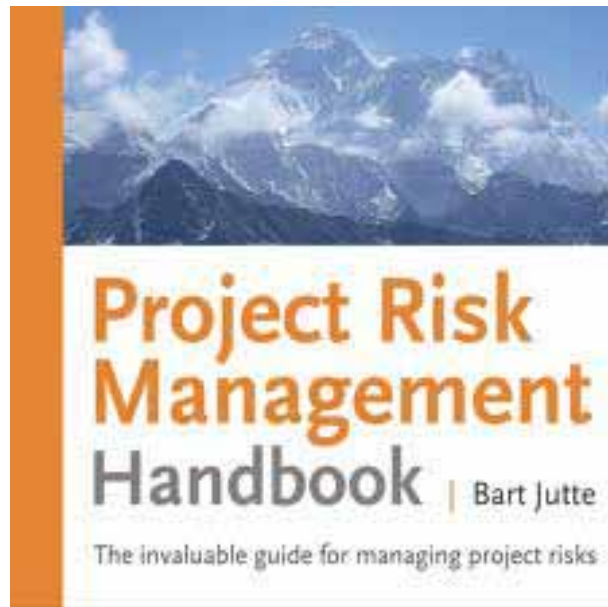
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# What is Risk Assessment?



•**Risk Management:** decision making process involving considerations of political, social, economic and technical factors with relevant risk assessment information - to implement appropriate response.



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# What is Risk Assessment?

- **Risk Communication:** interactive exchange of information about risks among risk assessors, managers, media, interested groups and the general public.



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# Who is risk analysis for and why is it being done?

**Everybody has a different interest**

Stakeholders must be clearly identified:

Public, regulators, project managers, scientists

**What part of the system?** Capture-transport-storage & Can it be separated?

**What time scales?** Both in planning and project life. Initial site selection? During injection? Post-closure? In 1,000 years?

**What aspects?** Technical, public, regulatory, economic, HS&E?

**What metrics?** \$\$, \$/tonne CO<sub>2</sub> lost? CO<sub>2</sub>?



[Citizensagainstco2sequenstration.blogspot.com](http://Citizensagainstco2sequenstration.blogspot.com)



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# What are the risks?

- Most CCS Risk assessments tend to focus on HS&E: Health, Safety and Environment related to long-term storage. This may or may not be the greatest risk.

Other important risks:

- Project financial risk
- Long-term liability
- Regulatory risk
- Public opinion risk
- Insufficient reduction of GHG



Jiscinfonet.ac.uk

CO2 FEP Database (<http://www.quintessa.org/co2fepdb/PHP/frames.php>)

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# Tools for Risk Assessment

- Informational
- Organisational
- Qualitative – Probabilistic?
- Quantitative – Probabilistic!



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Different tools are appropriate and useful for different tasks – and may be used at different times and/or for different stakeholders.

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# Tools for Risk Assessment

## Informational: Risk Register

Event	Cause	Mitigation
<b>Lack of Public Support</b>	<ul style="list-style-type: none"> <li>• Insufficient consultation and education</li> <li>• Misinformation</li> <li>• Lack of trust of government and CCS operating companies</li> <li>• Cultural Sensitivities to sequestration</li> <li>• Low tolerance to risk</li> </ul>	<ul style="list-style-type: none"> <li>• Educate about CCS process and risks</li> <li>• Consultation</li> <li>• Transparent government decision making process</li> <li>• Robust risk assessment and Monitoring and verification programmes</li> </ul>
<b>Not Economically Viable</b>	<ul style="list-style-type: none"> <li>• Price of carbon too low</li> <li>• Cost of capture, transport and CO<sub>2</sub> sequestration too high</li> <li>• Cost of sequestration higher than alternative mitigation measure</li> </ul>	<ul style="list-style-type: none"> <li>• Increase price of carbon via taxation</li> <li>• Decrease the cost of CCS</li> <li>• Introduce incentives for sequestration</li> <li>• Government funding (if considered of vital importance)?</li> </ul>
<b>Lack of operational Framework</b>	<ul style="list-style-type: none"> <li>• CCS legislation incomplete</li> <li>• Long term liability unresolved</li> <li>• Uncertainty of economic model for CCS</li> <li>• Insurance/reinsurance not available</li> </ul>	<ul style="list-style-type: none"> <li>• Government regulates CCS and accepts long term liability</li> <li>• Robust risk modelling</li> </ul>



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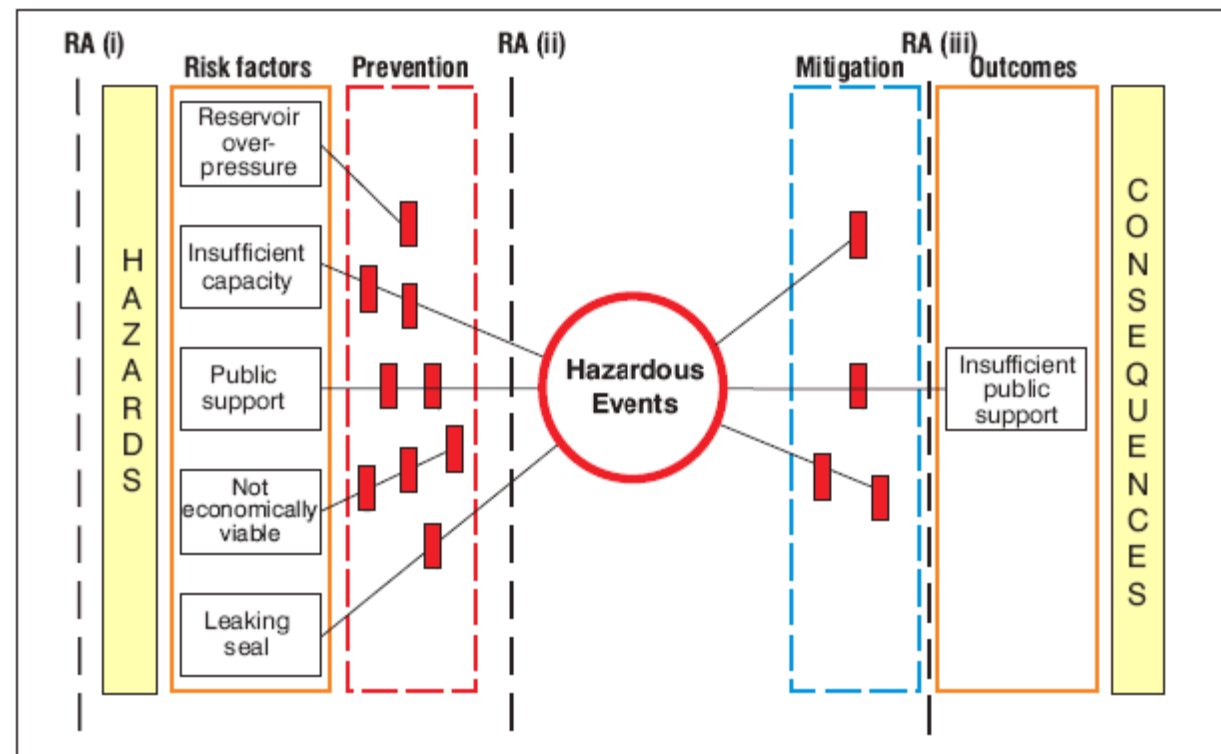


# Tools for Risk Assessment

## Organisational: Bow-Tie

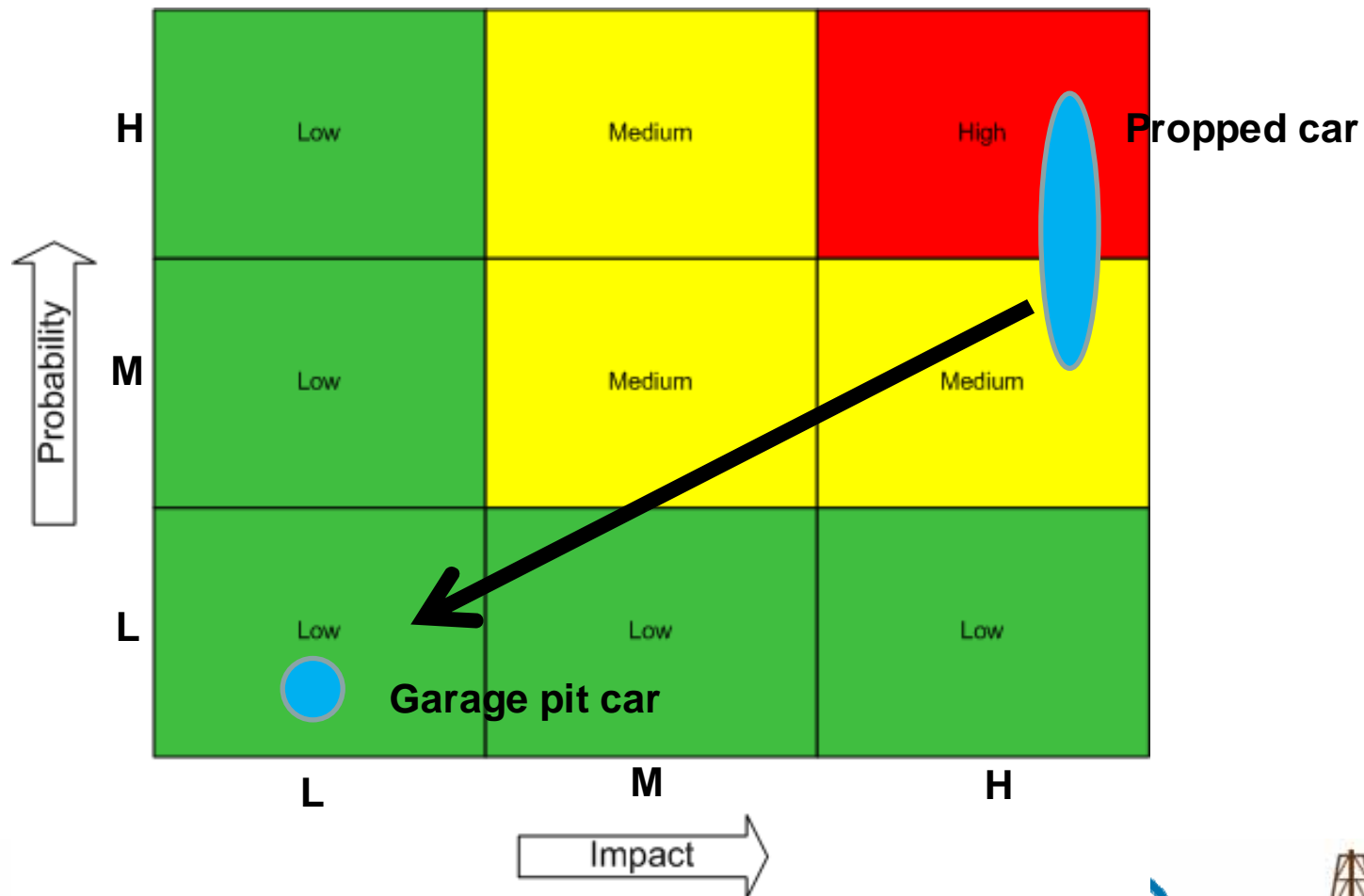
- Risk management
- Mitigation
- Presentation

RISK PREVENTION AND MITIGATION BOW-TIE DIAGRAM



# Tools for Risk Assessment

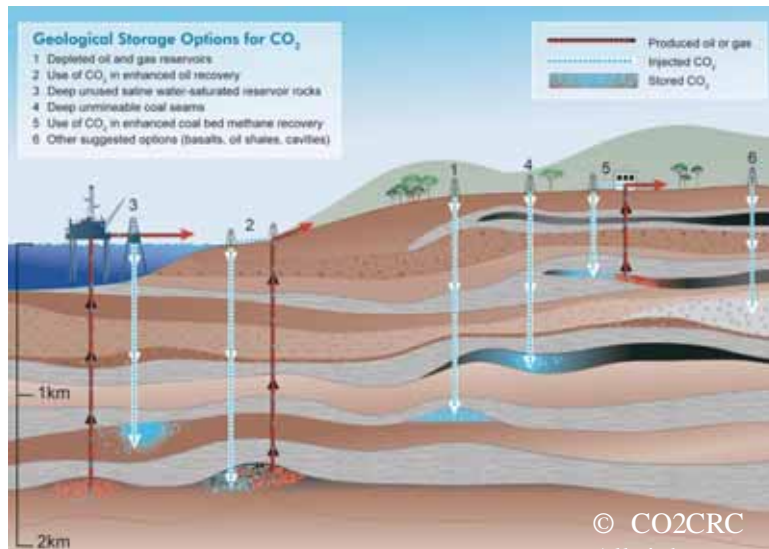
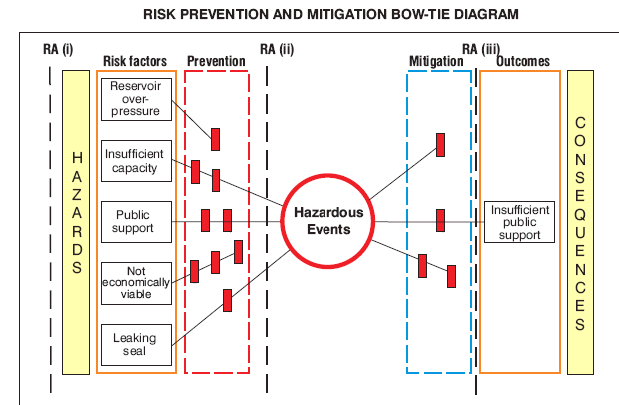
## Informational and Qualitative: Risk Matrix



# Tools for Risk Assessment

## Systems Analysis: Qualitative and Non-integrated

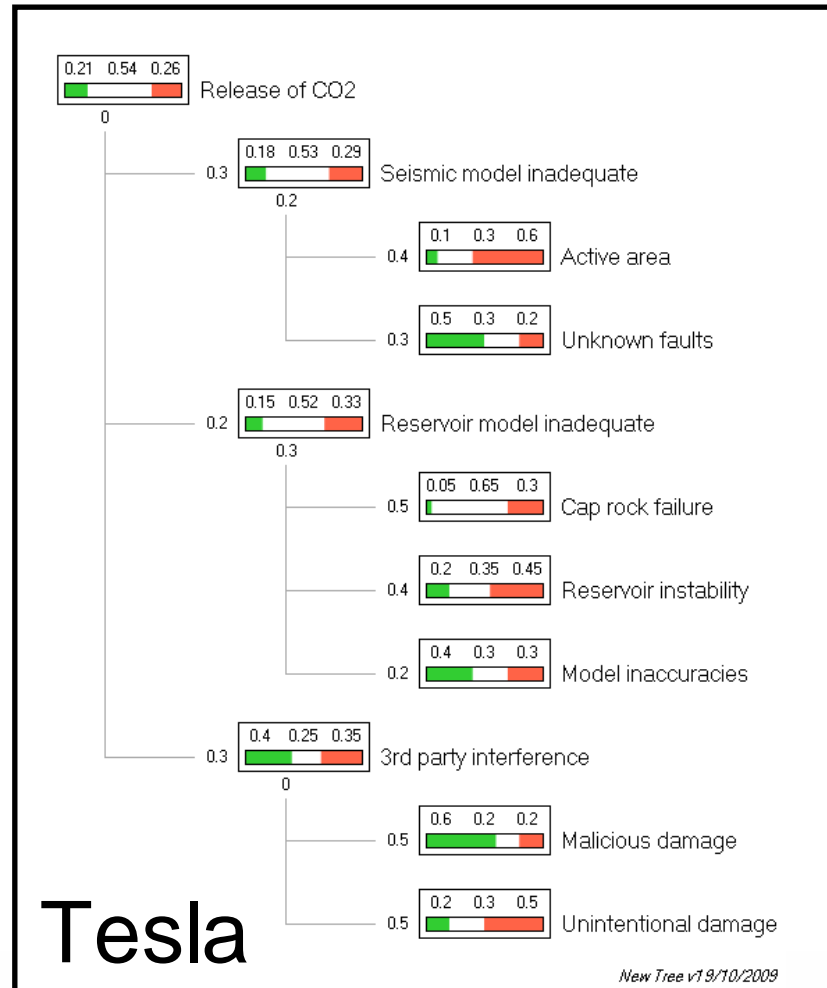
Event	Cause	Mitigation
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**RISK**

# Tools for Risk Assessment

## Systems Analysis: Quantitative and Integrated



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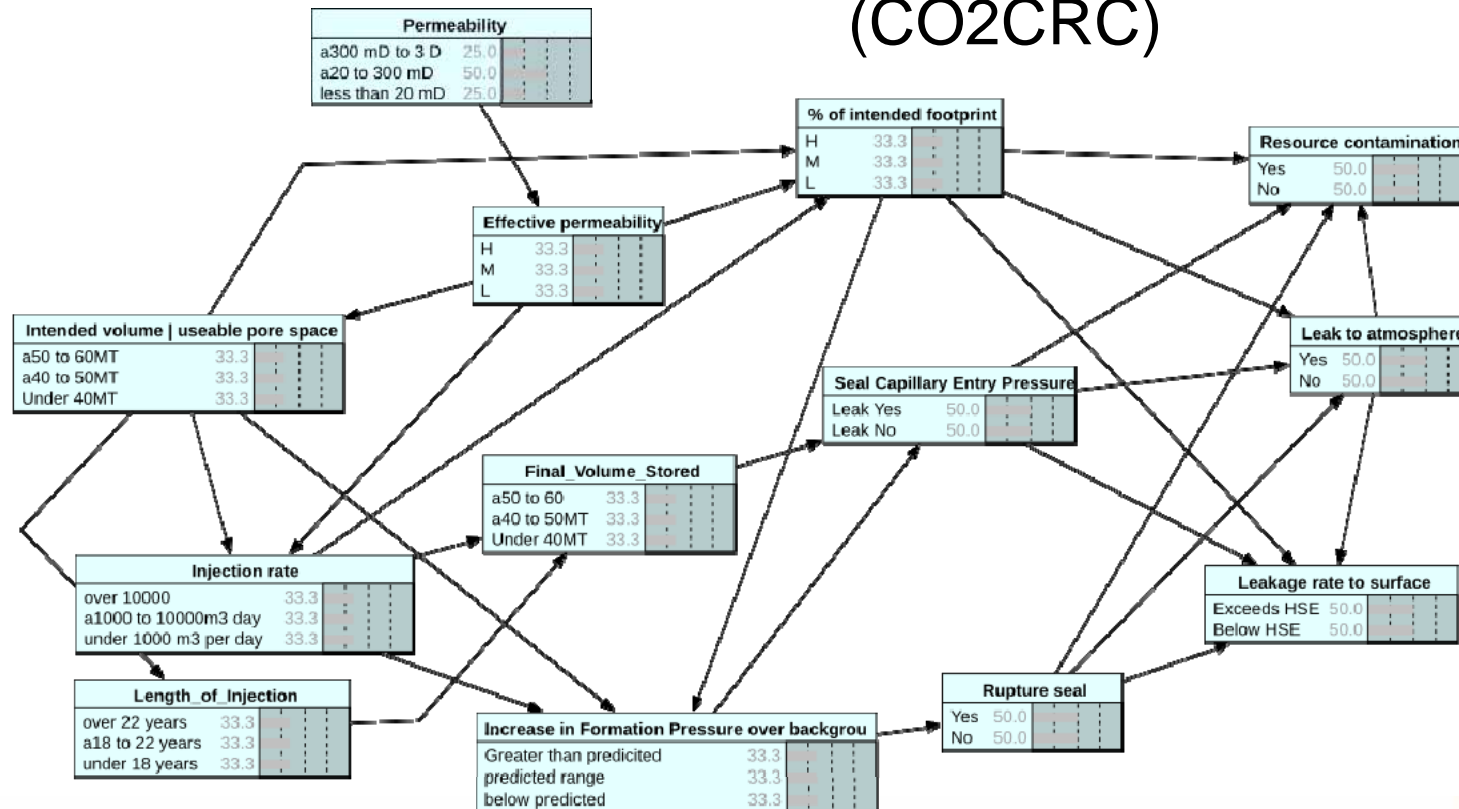
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# Tools for Risk Assessment

## Systems Analysis: Quantitative and Integrated

### Bayesian Belief Network (CO2CRC)



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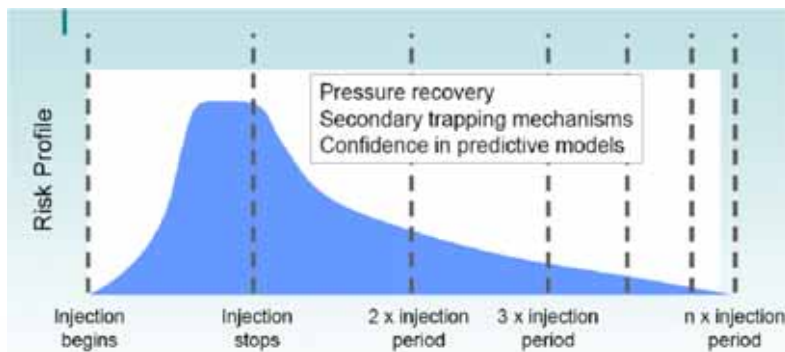
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# Key Challenges to Risk Assessment

- Relatively limited knowledge of system
- Usually working with extreme probabilities that change through time.
- Expert elicitation.
- Identification of stakeholders.
- Communication with (multiple) stakeholders.
- Appropriate resourcing.



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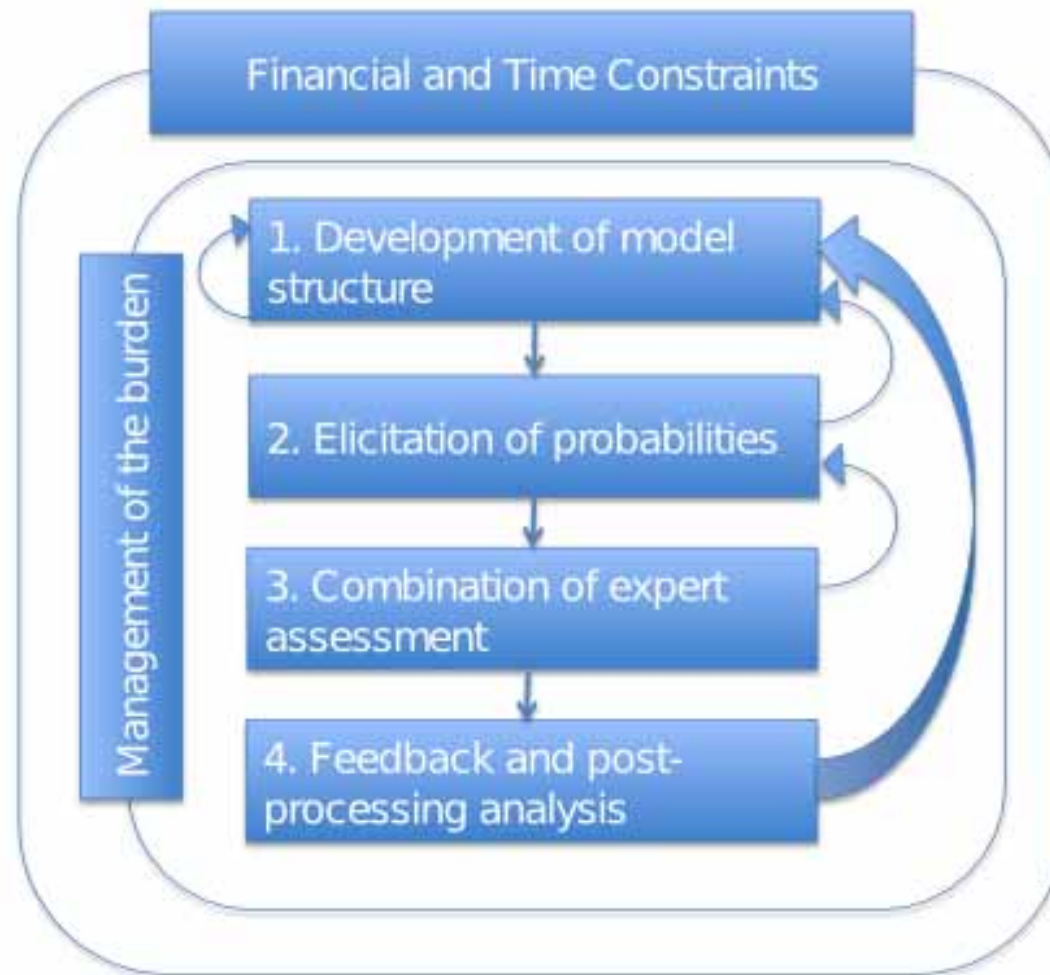


# Expert Elicitation

- Limited Knowledge
  - (informed) Quantitative answers often difficult to provide
  - Models/analogues not available for everything
  - Sometimes overly simplistic
- Extreme Probabilities
  - Probabilities of events generally very small – tricky to conceptualise!



# Structured Expert Elicitation



# Key Challenges to Risk Assessment

## Communication and Stakeholders

- Plan and begin risk assessment in early stages.
- Allow for appropriate resourcing and engage experts throughout the entire process.
- **Continually work with and engage stakeholders: answer the questions they are asking.**
- Ensure that risk assessment process transparent with outputs in a format easily understood by stakeholders.



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# Conclusions

- Risk Assessment must be designed and executed in a risk management context.
- System-wide assessment is likely to be required.
- Stakeholders must be identified early and engaged throughout the process.
- Appropriate resourcing is necessary.
- In most regions regulations are still undecided; this will impact risk assessment.
- Good expert elicitation is essential but not easy.
- Risk assessment will improve as more data is collected.



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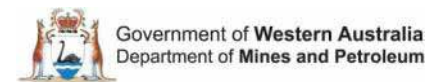
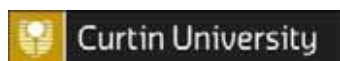


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