Shale gas development in South Africa

Shale gas landscape:
- Policy drive - National Development Plan (2012)
- Controversial debate, contested science, polarised positions
- A transparent process of evidence and assessment required

Strategic Environmental Assessment (SEA) for Shale Gas Development in South Africa
- Commissioned by the Republic of South Africa in February 2015
- 5 national departments, 3 science councils leading
- To provide an integrated assessment and decision-making framework to enable South Africa to establish effective policy, legislation and sustainability conditions under which shale gas development could occur
Shale gas scientific assessment

- 146 authors and 75 independent peer review experts from RSA, US, UK, EU, Canada, Australia & others
- 17 topics (including geophysics, water resources, terrestrial biodiversity, air quality, social fabric, visual and noise, heritage resources, agriculture, tourism, waste management, infrastructure planning, energy planning and economics)
- within a 171 811 km² study area

http://seasgd.csir.co.za/scientific-assessment-chapters/
Development of Scenarios

- Collaborative process: more than 60 experts from the oil- and gas industry, petroleum geologists, engineers, energy planners; and natural- and social scientists
- Creation of 3 cumulative scenarios + a dynamic Reference Case (no shale gas development but regional trends continue on observed trajectories)
- Scenarios developed in an incremental approach based on:
  - identification of major concerns = nominal risk associated with increasing shale gas development activities in the sensitive receiving environment of the Central Karoo
  - determination of major uncertainties = volumes of economically recoverable gas reserves.

→ scenarios provide the qualitative and quantitative information from which the assessment of future activities can be made across a range of spatial and temporal scales.
Scenarios: brief overview

- **Reference Case scenario (S0)**
  - No shale gas development.

- **Exploration Only scenario (S1)**
  - Results from exploration: production is not economically viable.
  - All sites are rehabilitated, drilled wells permanently plugged and monitoring of the abandoned wells implemented.
  - National energy supply in South Africa is supported by imported natural gas either via pipeline or from Liquefied Natural Gas (LNG) importation.

- **“Small Gas” scenario (S2)**
  - Results from exploration: small, but economically viable, shale gas resource.
  - Approximately 5 Tcf of gas is produced from 550 wells on about 55 wellpads in one 30 x 30 km production block.
  - Downstream development results in a 1 000 megawatt (MW) combined cycle gas turbine (CCGT) power station located less than 100 km from the production block.

- **“Big Gas” scenario (S3)**
  - Results from exploration: large shale gas discovery of 20 Tcf is made, produced from 4100 wells on about 410 wellpads distributed across four production blocks.
  - Downstream development results in the construction of two CCGT power stations (each with a generation capacity of 2 000 MW) and a gas-to-liquid (GTL) plant located at the coast with a refining capacity of 65 000 barrels (bbl) per day.
Cumulative/Incremental Scenarios:

**Four Scenarios:**
- 0 → Reference case
- 1 → Exploration only
- 2 → Small Gas (5 Tcf)
- 3 → Big Gas (20 Tcf)
Risk Assessment Approach

- Scenario-based risk assessment approach combined with spatial modelling → integrated ‘picture’ of cumulative risk.

- Sensitivity of spatially explicit receiving environments was classified and mapped to enable the assessment of risks per sensitivity class, with- and without mitigation, across the four scenarios:
  - Without mitigation’ : inadequate governance capacity, weak decision-making and non-compliance with regulatory requirements
  - ‘With mitigation’ : effective implementation of best practice principles, adequate institutional governance capacity and responsible decision-making.

- Risk was determined by estimating the likelihood of events or trends occurring, in relation to their consequences:

  \[ \text{Risk} = \text{likelihood} \times \text{consequence} \]

  ranging from very low to very high risk
Risk = likelihood x consequence
Integrated risk model

- model developed per scenario with- and without mitigation, based on the allocation of sensitivity ratings to geographically distinguishable receiving environments and the determination of risk profiles for these sensitive areas of the receiving environment.

- Spatially explicit risk profiles overlayed and depicted using the ‘maximum rule’ to prioritise the highest risk areas over those of lower risk.

- The risk model aims to demonstrate the evolution of the risk profile across the four scenarios for the full life-cycle of shale gas development activities and to test the efficacy of proposed mitigation actions in reducing risks.
### Example of risk table and mapping

**Topic n**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Scenario</th>
<th>Location</th>
<th>Without mitigation</th>
<th>With specified mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Likelihood</td>
<td>Consequence</td>
</tr>
<tr>
<td>xxx</td>
<td>Reference Case</td>
<td></td>
<td>very unlikely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Exploration Only</td>
<td>Very High sensitivity</td>
<td>unlikely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Small Gas</td>
<td></td>
<td>very likely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Big Gas</td>
<td></td>
<td>almost cert</td>
<td>substantial</td>
</tr>
<tr>
<td>xxx</td>
<td>Reference Case</td>
<td>Low sensitivity</td>
<td>very unlikely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Exploration Only</td>
<td></td>
<td>very unlikely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Small Gas</td>
<td></td>
<td>unlikely</td>
<td>substantial</td>
</tr>
<tr>
<td></td>
<td>Large Gas</td>
<td></td>
<td>not likely</td>
<td>substantial</td>
</tr>
</tbody>
</table>

Based on explicit locations of impact in relation to existing sensitivities, the team of experts determined risk profiles...
Risk profile with and without mitigation: S0

without mitigation

with mitigation
Risk profile with and without mitigation: S1
Risk profile with and without mitigation: S2
Risk profile with and without mitigation: S3
Integrated overlayed risk model (1/2)
Integrated overlayed risk model (2/2)

2 Small Gas

3 Big Gas

Composite risk of shale gas development

RISK

Very low, Low, Moderate, High, Very high

Protected area - not available for SCD

1:5 413 780
Concluding thoughts (1/2)

• Risk modelling provide information on evolving cumulative risk across different scenarios taking into account the possible implementation of mitigation measures.

• Decision making should be based on evidence-based assessment and robust regulatory framework.

• Most of the features mapped at the scale of this assessment would require additional project-level assessment processes (i.e. specific development applications where the nature, location and extent of shale gas development activities are clearly defined) in order to ground-truth sensitive features on-site.
• South Africa is in the advantageous position of being able to accumulate a baseline dataset and start building or supporting the institutions capable of collecting, managing and analysing that data in a responsible manner e.g. Biogaps project.

• Decisions regarding shale gas development should be considered in a ‘step-wise’ manner with baseline data repeatedly collected and fed back into the evidentiary base to critically test decisions, the efficacy of management actions and scientific assumptions.
For more information please visit the website for Shale Gas SEA: http://seasgd.csir.co.za/