

Modelling Social-Ecological Risks of Shale Gas Development in the Central Karoo*

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Abstract

Three plausible scenarios for shale gas development in the Central Karoo were developed, and the risks associated with each development scenario assessed by experts across seventeen strategic issue topics. Risk, before and after mitigation, was determined by the collective consideration of the consequence of an impact and its likelihood of occurrence. Risk profiles were generated for spatially explicit impacts in distinguishable receiving environments, and overlaid to create a composite social-ecological risk model. The risk model illustrates the evolution of the cumulative risks across the scenarios, representing the full life-cycle of shale gas development, and the efficacy of mitigation in reducing risks. Given the expanse of the study area (171,811 km²) and the relatively small physical surface footprint of shale gas development activities, mitigation best-practice can be best achieved by the application of the mitigation hierarchy, prescribing avoidance of impacts first. This may be best achieved by effective project planning, especially by siting surface infrastructure to not coincide with critical environmental features. The results of the risk modelling suggest that the cumulative risks of shale gas development, at the large-scale gas production scenario end, may be near to exceeding developmental thresholds that could result in unacceptable changes to the social and ecological integrity of the Central Karoo. However, risks can be effectively reduced and moderated through adequate planning, best-practice mitigation, good governance - and the institutional capacity to enforce it.

Selected References

Scholes, R., P. Lochner, G. Schreiner, L. Snyman-van der Walt, and M. de Jager, 2016, Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks: Council for Scientific and Industrial Research, Document CSIR/IU/021MH/EXP/2016/003/A, ISBN 978-0-7988-5631-7.

Schreiner, G.O. and L. Snyman-van der Walt, 2017, Risk Modelling of Shale Gas Development Scenarios in the Central Karoo: International Journal of Sustainable Development and Planning. (In Press).



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Modelling social-ecological risks of shale gas development in the Central Karoo

Key results of the South African shale gas scientific assessment

Luanita Snyman-van der Walt

American Association of Petroleum Geologists

Workshop on

Exploration and development of Unconventional hydrocarbons:

Understanding and mitigating Geotechnical challenges through Conventional wisdom

Cape Town, 20-23 June 2017

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1. Background

Shale gas and fracking – a hot issue



Potential opportunities

- Economic benefits;
- Energy security;
- Reduced greenhouse gas (GHG) emissions (e.g. when replacing coal).



Potential risks

- Industry outpaces research, regulation, governance & infrastructure;
- Increased GHG emissions (leakage);
- Water use, contamination & legacy risk;
- Surface disturbance by physical infrastructure.

- Global cautious approach to shale gas development (SGD)
- Need for trusted and transparent information gathering and sharing process



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2. Independent scientific assessment

The need for an assessment

2010

The South African Department of Mineral Resources received five Exploration Right applications to explore for shale gas from three different companies.

- **Uncertainty** about distribution and magnitude of gas in the Karoo basin.
- **Lack of experience** in gas activities and infrastructure.
- Potential **social and ecological consequences**.

2015

The South African Government commissioned an independent scientific assessment.



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2. Independent scientific assessment *Assessment structure*

- 18 month process
- Led by 3 national science councils
- 2 project governance groups
- “Scenarios & Activities” + 17 topic specific chapters
- 146 authors
- 75 independent peer reviewers (10 countries)
- 2 rounds of public outreach in the Karoo
- 114 stakeholder reviewers
- Over 600 registered stakeholders
- Published as citeable, peer reviewed, ISBN numbered book available at <http://seasgd.csir.co.za/>

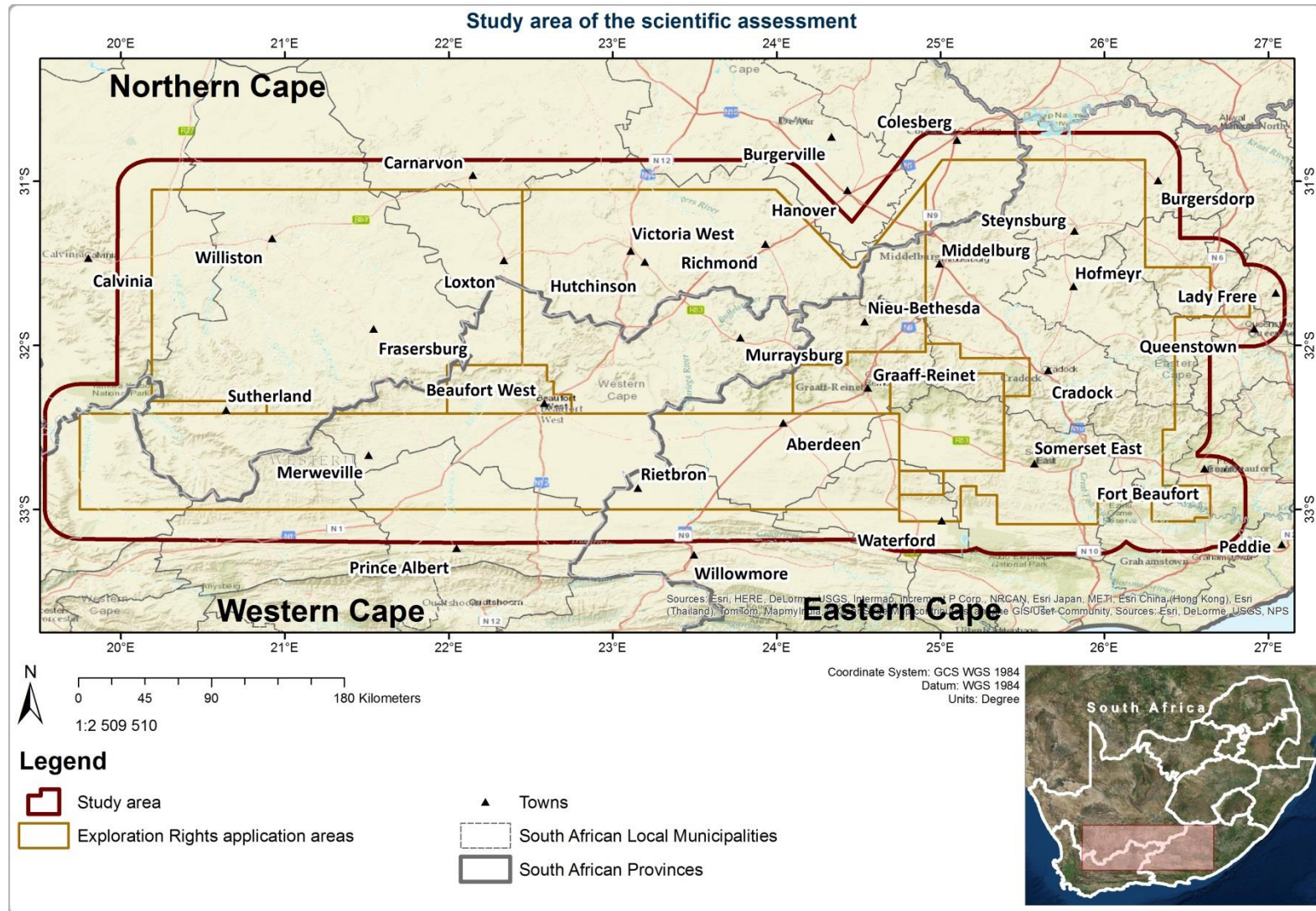


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3. Assessment approach

Study area





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3. Assessment approach *Strategic issues*





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3. Assessment approach *Scenarios development*

Scenario development

- S0: Reference case
- S1: “Exploration only”
- S2: “Small Gas” (5 Tcf)
- S3: “Big Gas” (20 Tcf)



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3. Assessment approach

Quantified scenario activities

Scenario	S1	S2	S3
Economically recoverable gas (tcf)	-	5	20
Production block/s [30 x 30 km well field]	-	1	4
Combined cycle gas turbine [1 000 MW]	-	1	-
Combined cycle gas turbine [2 000 MW]	-	-	2
Gas-to-liquid plant [65 000 barrels / day]	-	-	1
Number of well pads [2 ha each]	30	55	410
New roads (km), [unpaved, 5 m wide]	30	58	235
Total area of well pads and new roads (ha)	75	199	998
Percentage spatial coverage of study area	< 0.0001	0.0002	0.0009
Total number of truck visits	45 000	365 000	2 177 000
Industry water needs (m ³), [50% re-use]	319 110	6 056 160	43 087 235
Flowback waste (m ³)	101 400	5 573 900	40 356 400
Other hazardous waste (t) [e.g. oil, grease]	85	635	3 185



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3. Assessment approach

Risk assessment

Risk assessment

- Risk = consequence of an impact (+ / -)
X the likelihood of its occurrence



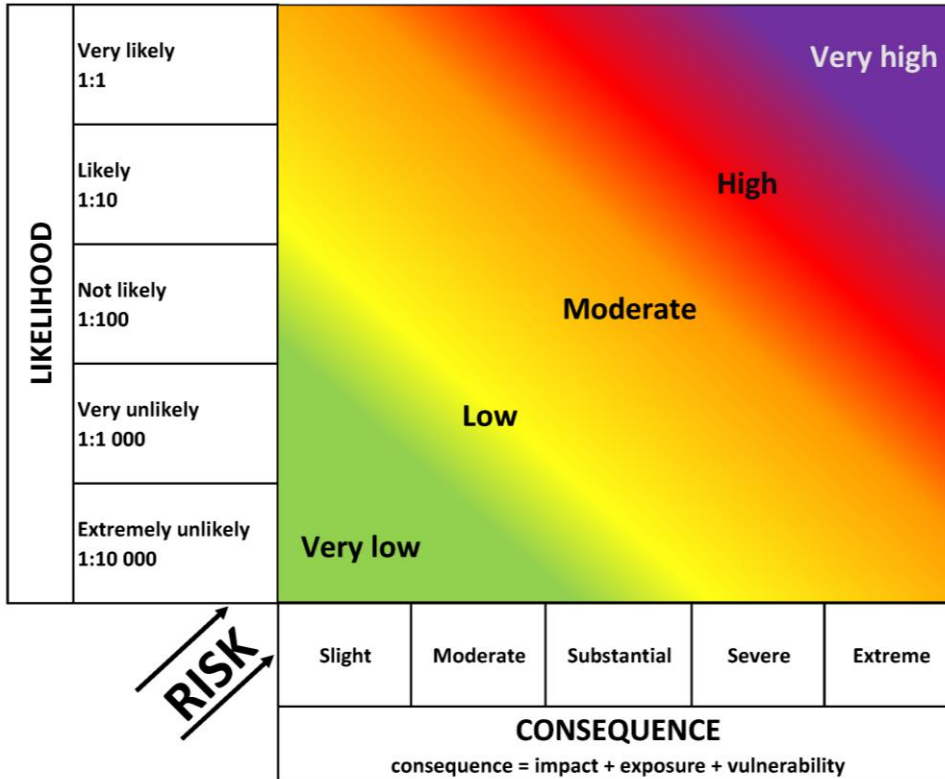
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3. Assessment approach

The concept of risk

- Define consequence terms: e.g.
 - Slight: ‘20 % physical loss of a near threatened biodiversity habitat’;
 - Extreme ‘80 % loss of the same habitat’.
- Assess with- and without mitigation, which assumes:



Without mitigation	With mitigation
• Inadequate governance capacity	• Effective implementation of best-practice principles
• Weak decision-making	• Adequate institutional governance capacity
• Non-compliance with regulatory requirements	• Responsible decision-making



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4. Results

Risk assessment

High (with mitigation)

- Reduced surface- and groundwater availability for other water users (S2; S3)
- **Impacts on farming and agriculture (S2; S3)**
- **Reduced tourists, tourism enterprises and financial losses to the rural economy (S2; S3)**
- Human in-migration, altered physical security and new power dynamics (S1; S2; S3)
- Loss of 'sense of place' for people who live in or value the Central Karoo (S0; S1; S2; S3)
- **Visual intrusion of activities into the landscape (S2)**
- **Impacts on built heritage, archaeology and cultural landscapes (S1; S2; S3)**
- Noise disturbance to humans and animals (S2; S3)

Moderate (with mitigation)

- Mismatched energy infrastructure (S2; S3)
- Network capacity to evacuate electricity from CCGTs (S2; S3)
- **Air pollutants diminish air quality (S1; S2; S3)**
- Fugitive GHG from wells and supporting infrastructure (S3)
- **Earthquakes damaging heritage resources and human health (S3)**
- Contamination of groundwater resources through diminished well integrity and preferential geological pathways (S2; S3)
- **Physical disturbance of watercourses (S2; S3)**
- **Contamination of surface water through contact with flowback discharge and contaminated groundwater (S2; S3)**
- **Impacts on biodiversity and ecological processes (S2; S3)**
- Impacts to public finances due to externality costs and reduced property values (S3)
- Reduced human health through exposure to contaminated water and air (S2; S3)
- Worker physical injury through contact with traffic or machinery (S2; S3)
- **Electromagnetic interference with radio astronomy (S2; S3)**
- Local road construction and pressure on Municipal services and infrastructure (S2; S3)

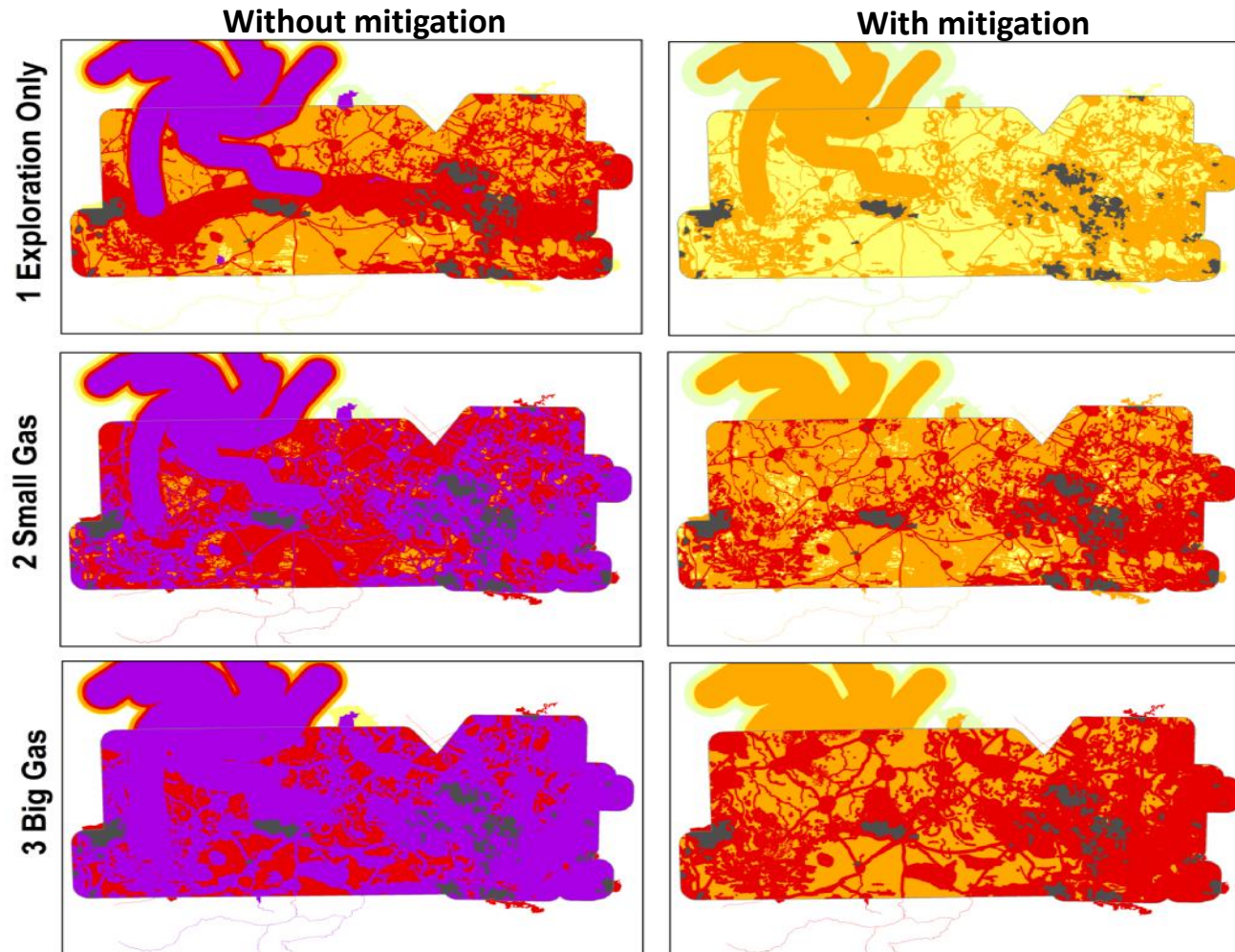


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4. Results

Spatial representation of risk



Exploration Only
0.0001 % of study
area directly affected

5 tcf gas
0.0002 % of study
area directly affected

20 tcf gas
0.0009 % of study
area directly affected

Composite risk of shale gas development

RISK



Very low

Low

Moderate

High

Very high

Protected area -
not available for SGD



0 125 250 500 km
1:5 413 780



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5. Conclusion

Key overarching findings

- **Exploration risks are manageable:** There are now fatal flaws associated with exploration activities, even those undertaken at a high intensity;
- **Production thresholds:** Current estimates are that production related activities in the Central Karoo could become too risky beyond 20 tcf;
- **Build institutional capacity:** The ability of South Africa to manage the risks of SGD depends on the strength of its institutions;
- **Avoidance is best:** Most risk can be mitigated, even at production scale, if basic avoidance best practice principles are maintained;
- **Effectively reduce risk to acceptable levels:**

PLANNING

MITIGATION

GOVERNANCE

CAPACITY



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5. Conclusion

Strategic management actions



Communicate to Government that production of shale gas is not a *fait accompli*, it could only occur following promising results during a detailed and comprehensive 10 year exploration programme.



Promote strategic energy planning for shale gas development, should it prove to be a commercially viable resource.



Implement good practice guidelines for air quality management.



Develop standards for GHG emissions.



Develop, implement and maintain an air quality and GHG monitoring station in the Central Karoo.



Install additional seismicity monitoring stations in the study area.



Develop a policy statement regarding the use of water in the Central Karoo.



Ensure baseline and ongoing water monitoring data is adequately collected.



Develop a policy statement regarding the disposal of waste in the Central Karoo.



Develop a landscape biodiversity baseline monitoring programme.



Develop an adequate financing and fund review model for abandoned or decommissioned wells.



Ensure institutional capacity development and integrated governance.



Develop guidelines for heritage assessments and monitoring.



Develop a Memorandum of Understanding between SAHRA and each Provincial Authority.



Investigate the feasibility of using rail to mitigate road risks.



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Thank you

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6. References

This presentation is based on, and demonstrates the findings of:

Scholes, R., Lochner, P., Schreiner, G., Snyman-van der Walt, L. and de Jager, M. (eds.). 2016. Shale Gas Development in the Central Karoo: A Scientific Assessment of the Opportunities and Risks. CSIR/IU/021MH/EXP/2016/003/A, ISBN 978-0-7988-5631-7.

and

Schreiner, G.O. & Snyman-van der Walt, L. 2017. Risk modelling of shale gas development scenarios in the central Karoo. *International Journal of Sustainable Development and Planning*. (In Press).

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Schreiner, G.O. & Snyman-van der Walt, L. 2017. Modelling social-ecological risks of shale gas development in the Central Karoo: key results of the South African shale gas scientific assessment. CSIR document number: CSIR/IU/021MH/EXP/2017/0005/A. Presentation at the *American Association of Petroleum Geologists workshop on exploration and development of unconventional hydrocarbons: understanding and mitigating geotechnical challenges through conventional wisdom*, Cape Town, South Africa, 20 June 2017.