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# **Evidence-based and participatory processes in support of shale gas policy development in South Africa**

## **1 Abstract**

Scientific assessments are social processes which embrace exchanges between scientists and society. They are designed to allow for multiple interactions and encourage the co-generation of knowledge among a diversity of participants. Such a process was attempted in the South African context, applied to the contested social issue of shale gas development in the Central Karoo. The three principles underpinning scientific assessments (legitimacy, credibility and saliency) are advanced through two key process mechanisms: participation and governance. This chapter discusses the key participation and governance systems designed as part of the scientific assessment. The chapter provides useful reference points which will advance the understanding of how to implement trustworthy processes within contested social and political decision-making landscapes. Considering South Africa's comprehensive regulatory system, it remains clear that if shale gas development is to find local traction over the following decades, the decisions that lead to that point will have to be based on evidence which society, broadly defined, considers robust and reliable.

## **2 Introduction**

The science-policy interface is an iterative, multi-way engagement process. It entails the generation of knowledge from processes which are shared between researchers, practitioners, policy-makers and stakeholders, the so called 'co-production' of knowledge (Scholes et al., 2017). Evidence-based and participatory processes are known to be useful for generating knowledge for issues of significant technical complexity, where there exists scientific uncertainty and societal conflict (Ash et al., 2010). In spite of an established understanding of the importance of policy informed by good science, operationalising the science-policy interface has proved challenging and attempts to do so have not necessarily translated into cogent decision-making (Fernández, 2016).

The scientific assessment of shale gas development<sup>1</sup> in the Central Karoo (see Scholes et al., 2016), requested widely by the stakeholder community in South Africa and commissioned by government in 2015, offers an example of evidence-based and participatory processes which sought to promote a convergence of societal opinion on a highly divisive national issue (De Wit, 2011). Drawing on the key lessons from the South African experience of running a large, complex and multidisciplinary assessment, it is intended that the process, especially those aspects that relate to project governance and stakeholder participation, will serve as a useful reference point for future assessment processes of high societal contention in the arena of shale gas or other important social questions.

### **3 International and local context**

By 2010, the shale gas revolution in the United States had sparked worldwide interest in domestic gas development. Global oil prices were around \$100 per barrel, and horizontal drilling and gas extraction technologies were rapidly improving (Zuckerman, 2013). Shortly thereafter, the United States Energy Information Administration issued a series of reports providing initial assessments of world shale gas resources, with South Africa's Karoo Basin ranking in the top ten globally in terms of technically recoverable reserves (Kuuskraa et al., 2011). Some excitement about the potential for shale gas in South Africa followed, largely inspired by the shale gas boom in the United States (De Wit, 2011).

The main Karoo geological Basin covers approximately 700 000 km<sup>2</sup>, representing more than half the land surface of South Africa (Raseroka and McLachlan, 2008). Deep drilling during the 1960s and 1970s, has shown shale formations of the Karoo Basin to contain natural gas at depths of around 2 - 3 km, although in the absence of modern exploration data, the magnitude, distribution and economic recoverability of the gas resource is not well understood<sup>2</sup>. Even though the Karoo Basin is characterised by geological complexity, such as the presence of dolerite intrusions, the region is still considered an attractive target for shale gas, since the target formations have a relatively high organic carbon content and occur over a large area (Department of Mineral Resources, 2012).

The South African energy system is currently based mainly on coal mined in South Africa, complemented by imported oil and petroleum fuels with small quantities of natural gas. Most energy in South Africa is supplied as electrical power, about 90% of which is generated by burning coal. The

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<sup>1</sup> The term shale gas development, is used to collectively refer to the full life-cycle of activities associated with shale gas exploration, production, downstream utilisation and eventual decommissioning of gas extraction, transportation and combustion infrastructure.

<sup>2</sup> Results from the assessment indicate that technically recoverable reserves of shale gas within the study area of the Central Karoo could range between 71 and 153 Trillion cubic feet (Tcf). Taking a conservative approach, applying a recovery factor of around 10%, the 'Small' and 'Big Gas' scenarios considered in the assessment were 5 and 20 Tcf of economically recoverable gas respectively (Scholes et al., 2016).

integration of natural gas into the energy mix is widely advocated in policy (Department of Minerals and Energy, 1998). The National Development Plan (NPC, 2013), the overarching guiding plan for the country, encourages increasing natural gas use in the energy mix, irrespective of whether that gas is imported or sourced domestically. This policy objective is supported by evidence that including more natural gas in South Africa's energy mix would make the energy system more resilient, efficient, cheaper and reliable (Scholes et al., 2016).

In 2010 the national Department of Mineral Resources received five Exploration Right applications to explore for shale gas from three different international companies. Collectively, the scope of the Exploration Right applications cover 124 000 km<sup>2</sup> of the Central Karoo and include exploration campaigns involving seismic surveys, deep vertical boreholes and horizontal drilling with test hydraulic fracturing (Golder Associates, 2011, 2015; SRK, 2015).

The Exploration Right application processes, ongoing since 2009, have been met with resistance by some organised community groups in South Africa<sup>3</sup> (Glazewski and Esterhuyse, 2016). The “great shale debate in the Karoo” exploded into South African popular culture around this time and quickly became a polarised argument between those attracted by the opportunity of economic prosperity and energy independence versus those who believed shale gas development would result in unacceptable environmental and social consequences (De Wit, 2011). In response to this concern, the South African Cabinet imposed a moratorium on decisions relevant to the shale gas Exploration Right applications and ordered a preliminary intergovernmental assessment into the risks associated with hydraulic fracturing (Department of Mineral Resources, 2012).

Following the results of the assessment, the moratorium was lifted in 2013, with the recommendation to “authorise hydraulic fracturing...under an augmented regulatory framework”. Technical regulations, which prescribe the technological and best practice processes which must be employed during shale gas development processes, were released in 2013 for public comment (RSA, 2013). Voluminous submissions from numerous non-governmental organisations (NGOs) and individuals were received within a mandatory public comment process (Glazewski and Esterhuyse, 2016), after which the regulations were promulgated (RSA, 2015). Shortly thereafter, the regulations were contested in the Courts by a coalition of South African anti-shale gas development organisations, citing a lack of relevant scientific content in the regulations and insufficient public engagement on the intergovernmental assessment and technical regulations gazetting process (TKAG, 2015a). The court challenge is still pending at the time of writing (June 2017) and no decisions on the Exploration Right applications have been made.

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<sup>3</sup> See Treasure the Karoo Action Group (TKAG), [www.treasurethekaroo.co.za](http://www.treasurethekaroo.co.za)

## **4 An uncertain socio-ecological and regulatory environment**

The Central Karoo is a semi-arid environment which assigns a premium value on freshwater resources for sustaining local communities and their livelihoods. Towns and farmers mainly rely on groundwater resources for domestic and livestock supplies and the sustenance of local economic activity, including irrigated agriculture and tourism. The dry, extensive landscapes of the Central Karoo are experienced by many people as a place of austere but compelling beauty. The region includes high levels of biodiversity, distinctive heritage features and scenic resources which make it attractive to a growing niche tourism market with ‘space, silence and solitude’ becoming hallmarks of tourism brand and lifestyles (Scholes et al., 2016).

On the other hand, the Central Karoo is a region with high levels of poverty and limited economic opportunity for local people. The regional gross domestic product is low when compared to towns and cities located outside the region and local government already have a major challenge of dealing with poverty and unemployment. Many municipalities are barely able to cope with current service delivery functions such as water provision, sanitation, electricity and roads management. Proponents of shale gas have promoted the industry as a means to enhance energy independence, reduce the national trade deficit and promote local economic development in a marginalised region of the country desperately in need of new growth and investment opportunities (Scholes et al., 2016).

This narrative bears similarities to that advanced by the South African government, which has made public commitments to initial shale gas exploration activities to prove or disprove economic recoverability. Such positions have been made at the highest levels of government, for example, through the national Cabinet and in statements made by the President, such as that in State of the Nation Address in 2014 where the President proclaimed that “we will pursue the shale gas option within the framework of our good environmental laws”.

Anti-shale gas development organisations have highlighted the fact that shale gas operations require relatively large amounts of water, proppant, fracturing fluids, trucks and other infrastructure to support a domestic gas industry, none of which are currently available in the Central Karoo. In addition, the prospect of shale gas development has created fears that municipalities may be overwhelmed by new tasks and challenges, and that municipal officials and politicians may succumb to undue influence from large companies.



In South Africa, the environmental management and development planning domains are dynamic and have been characterised by significant recent policy and law reform initiatives (Plit, 2016). In addition, South Africa does not have an unconventional gas industry and the potential for shale gas development has triggered the need to deeply consider an appropriate policy and legislative framework to regulate the industry should it advance (ASSAf, 2016).

## **5 The need for a participatory and transparent assessment**

Despite the fact that the moratorium had been lifted, the technical regulations promulgated and a continued political commitment to shale gas exploration; no decisions on any of the existing Exploration Right applications have been made. In order to provide a tested evidence-base, designed to promote a convergence of opinion among stakeholders rather than the damaging polarisation; government commissioned an independent scientific assessment of shale gas development in May 2015 (DEA, 2015) which was grounded in the principles of legitimacy, credibility and saliency (Ash et al., 2010).

Legitimacy means that the process must be mandated by the authorities responsible for decision-making and is enhanced by implementing a process perceived by a wide range of stakeholders as being fair and unbiased. This is usually achieved through considering a broad balanced range of values, concerns and perspectives from different stakeholders in society. Saliency means addressing the questions which society is concerned about in a comprehensive manner and in doing so, producing material which is strategically useful for policy-makers.

Credibility means meeting the standards of scientific and technical rigor where the sources of knowledge are considered trustworthy and independent. Appointing experts who are widely acknowledged by the stakeholders as having appropriate and leading knowledge and experience for the given topic (which may include 'indigenous' and 'local' knowledge, and expertise in fields not conventionally thought of as 'scientific'), and following a rigorous, transparent and documented peer review process, are considered essential. The extent to which the process achieved the implementation of the legitimacy, saliency and credibility principles will be discussed in the sections which follow.

Large-scale assessments on other topics characterised by simultaneously having high technical complexity and high societal interest, have been developed and refined over the past three decades through a series of modern scientific assessments, such as those conducted by the Intergovernmental Panel on Climate Change and the Intergovernmental Platform for Biodiversity and Ecosystems and

tested once in South Africa on the controversial issue of elephant management in conservation areas (Scholes and Mennel, 2008).

Drawing on the principles and learning from previous scientific assessment processes, the mission statement of the shale gas national assessment was drawn from the National Development Plan 2030 (NPC, 2013) and the Constitution of South Africa (RSA, 1996), and framed as a process designed 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” (CSIR, 2015).

The mission statement, developed in collaboration with government at the first Executive Committee meeting (see Section 5.1), was purposefully phrased in the conditional. It did not presume that development *will* occur, since no modern exploration has yet been undertaken, but does assume that it *could* occur if initial exploration results prove promising and the necessary environmental and planning permits are obtained.

Following the launch of the shale gas assessment in the public domain, the main anti-shale gas development organisation published a statement in support of the process: “We are most encouraged by this development. A strategic environmental assessment is a fundamental step in the appropriate evaluation of shale gas in South Africa, and it is a process for which we have been calling since 2011. TKAG will be involved in the process and it intends to use every opportunity to play a pivotal role – from defining terms of reference, to placing specific data in front of the assessors in an effort to ensure that government policy is informed by science” (TKAG, 2015b).

## **6 Participatory processes for the assessment**

Four, generally not mutually-exclusive, ‘pathways’ of participation, appropriate for various stakeholders, were provided through the South African assessment. This contrasts with the narrow public consultation which characterises most Environmental Impact Assessment (EIA) processes (Audouin and Hattingh, 2008). The four pathways were through: (i) project governance; (ii) the generation of salient questions and engagement sessions; (iii) content development through authorship; and (iv) commentary on and review of content.

### **6.1 Participation through project governance**

The Executive Committee and the Custodians Group were the two overarching governance structures commissioned to monitor conformity with the assessment process plan and principles as outlined in the 'process document' drafted by the project co-leaders (Scholes and Lochner, 2015).

[insert fig 1]

Figure 1: The Executive Committee comprised of the national and provincial government departments which commissioned the assessment. The Custodians Group consisted of 16 eminent people, drawn approximately equally from government, NGOs, the private sector including the oil and gas sector and the research community (after Scholes et al, 2016).

The key role of the Executive Committee was to ensure that the scope of the assessment was policy relevant, salient for government users and that the project co-leaders and management team kept the process within brief and budget, as outlined in the process document. The Executive Committee also helped to satisfy the South African Constitutional requirements for co-operative governance, between departments and between different levels of government (RSA, 1996).

Members of the Custodians Group were nominated by the Executive Committee, the management team and the broader stakeholder community based on their credibility in the sector they represented and on their organisational representativeness. The Custodians Group was tasked with providing feedback to the Executive Committee and their respective constituencies, that the pre-agreed process and principles were followed in accordance with the vetted process document. Their specific mandate was to evaluate the process guided by the following five key questions:

- 1) Does the assessment cover the material issues that are of concern to people?

- 2) Has the assessment followed the guidelines in the process document?
- 3) Do the author teams have the necessary expertise and show balance in their composition?
- 4) Are the identified expert reviewers independent, qualified and balanced?
- 5) Have all the review comments received from expert and stakeholder reviewers been addressed and have the responses been adequately documented in a public repository?

Members of the Custodians Group were not appointed as ‘representatives’ of their organisation in a narrow sense, but were expected to reflect the breadth of opinion from their sectors. The Custodians Group was neither ‘approving’ nor ‘disapproving’ of shale gas development, nor did it have a say on the detail of the content of the assessment. It was a trustworthy collective nominated by society, tasked with ensuring that the process of evidence collection, evaluation and presentation was comprehensive and unbiased. This distinction remained critical, especially for the NGO members of the Custodians Group, as they and their respective organisations did not necessarily agree with every outcome of the assessment. It was also critical for the individuals involved in the Custodians Group to communicate effectively with their constituencies about their involvement with, and role in the assessment, so as to avoid perceptions of co-optation.

[insert fig 2]

Figure 2: The composition of the Custodians Group, representing NGOs, government, research and constitutional bodies; and private sector members. Its purpose was to monitor the assessment process in terms of five specific process questions and report back to the Executive Committee and sector constituencies on the saliency, legitimacy and credibility of the process.

The final Custodians Group meeting was held in September 2016 before publication of the final draft assessment, after which the management team received sign-off from the Custodians Group, via the Chair, that the *process* undertaken has been comprehensive, balanced and fair in light of the available evidence and information.

## **6.2 Participation through the generation of salient questions**

Seventeen topics were addressed by the assessment and were generated by a combination of ‘top down’ and ‘bottom up’ dialogues (do Rosário Partidário, 2012) over the course of many months and engagements. Each topic was addressed as a specific chapter. Candidate topics were gleaned from peer reviews of shale gas development experience worldwide in the existing literature, assembled and organised into a large online repository by the assessment co-leads and management team.

‘Top down’ dialogues indicated that experience with shale gas development elsewhere in the world (mainly the USA, where shale gas development is at the most advanced stages) had revealed some potential negative consequences. This included the presence of gas in surface aquifers from deep sources following hydraulic fracturing (Vengosh et al., 2014) and methane leakage during the extraction and transportation of gas (Bradbury et al., 2013; Field et al., 2014). Surface disturbances associated with development activities such as road construction and increased traffic (Drohan et al., 2012); water and waste management (Rahm et al., 2013); and associated gas transport and utilisation infrastructures (Ziemkiewicz et al., 2014) were also reported. As were sensory impacts of shale gas development in non-industrial environments and the unintended socio-economic impacts of attracting migrant labour to ‘boomtowns’ in formerly rural economies (Christopherson and Rightor, 2011).

The outcomes of the ‘top down’ dialogues were unpacked in summary format and released to the public as a Zero Order Draft (ZOD) for comment. The ZOD was a reasonably detailed 60 page skeletal structure of the entire assessment including the risk assessment approach which would guide the assessment of each of the chapters. The ZOD included the structure, content and initial indication of the key issues which would be covered within the scope of each chapter. The ZOD was drafted in collaboration with the Integrating and Contributing Authors of the assessment following the first author meeting (see Section 5.4) and then debated with stakeholders and governance groups to check that the questions most relevant to society were suitably addressed within the scope of the ZOD.

This engagement was undertaken through an early round of three local community meetings in the Central Karoo in November 2015 and a consultative meeting with stakeholders, with the ZOD as the focal point of attention (see Figure 3). Initial meetings were important for setting a trustworthy base of engagement and the management team used multiple communication mediums such as face-to-face meetings, the publication of written documents, explanatory video graphics and materials on the project website (<http://seasgd.csir.co.za/>), interviews with the media, press releases and even

alternative communication methods such as art exhibitions. During these processes, stakeholders were asked the following three questions:

- 1.) Does the process as described in the process document seem fair, unbiased and transparent?
- 2.) Does the ZOD of the assessment cover all the material issues of concern?
- 3.) What additional issues or concerns need to be included within the scope of the assessment?

One example of a ‘bottom-up’ knowledge flow concerned the issue of human health. In the initial ZOD presented to stakeholders and governance groups, the issue of human health was not included as a standalone assessment chapter. Following engagement with the Custodians Group and the meetings held with general stakeholders, it was evident that stakeholders believed that the topic of human health was sufficiently important to warrant standalone investigation. Following this decision, made in collaboration with assessment participants, the co-leads and management team commissioned a separate assessment chapter for human health.

This bi-directional approach allowed for the incorporation of different types of knowledge (technical and tacit) to be obtained during the framing of the assessment scope. The engagements with the public at the outset may not have contributed significantly new information regarding the salient questions to be answered by the author teams; however, this was never the main purpose. The engagements served an important role in legitimizing the outcomes of the assessment with the broader stakeholder community by demonstrating a genuine interest in addressing the issues of concern to society (Ash et al., 2010).

The engagements were designed to get to know the relevant stakeholders and initiating or strengthening relationships with them. Through discussion and information sharing about the ZOD and broader process, stakeholders were able to form a credible vision and understanding of the assessment. It assisted in making the process salient for them, and improved the likelihood that they would use its outcomes as a basis for future decision-making.

### **6.3 Participation through generation of content**

The process leading to the development of the evidence-base in the 18 chapters of the assessment was highly inclusive. In order to advance the principles of credibility and saliency, the latter demonstrating balance and comprehensiveness, the assessment adopted a multi-author team approach, in contrast to the usual EIA approach of appointing a single consultant per topic. Each of the chapters had an average of six to eight authors, ranging between three (in the case of the earthquake chapter) and 45

authors (in the case of the biodiversity chapter) (refer to Table 2). The multi-author team concept relied on two principles:

- 1) That each major topic is addressed by a team of authors, each author being a recognised expert; and
- 2) That remuneration is based on covering expenses rather than at a level that could be reasonably construed to constitute an inducement to give a biased finding.

Authors comprising the multi-author teams within the specific chapters required acknowledged expertise and were drawn from a range of sectors such as research institutions, government, NGOs, universities and across different regions of South Africa to ensure a broad balance of interest was represented through the author structures. Authors were selected according to their formal qualifications, publications and experience, as well as widespread peer-group consensus based on their track record of valuable contributions on the topic.

Table 1: Author roles, remuneration structure and assessment responsibilities. The nomination of potential authors was open to the general public and the Custodian Group, the latter responsible for vetting the final author composition which was then commissioned by the management team to develop the chapters.

<b>Role and remuneration</b>	<b>Responsibility</b>	<b>Custodians Group role</b>
<b>Integrating Author (IA)</b> (1-2 per topic). Expenses plus token stipend for acknowledged time investment.	Chairs the chapter team meetings, allocates writing tasks, ensures they are done on time and to specification, allocates reviewer response tasks and ensures they are done. Experienced expert in own right, part of overall summary/synthesis team.	Approves Integrating Author selection based on expertise, experience, credibility, availability.
<b>Contributing Authors (CA)</b> (3-5 per topic). Expenses only, modest honorarium fee for self-employed.	Collate, evaluate and summarise available information. Lead writer of an allocated section, participates in team discussions on entire topic and takes collective responsibility for it. Responds to reviewer comments in allocated section and revises drafts accordingly.	Approves Contributing Author team based on expertise and balance, can suggest authors.
<b>Corresponding Author (CoA)</b> (No limit, as needed). No fee.	Provides short input text on area of narrow or special expertise. May be asked to respond to reviewer comments on the material provided.	Notified of corresponding authors.
<b>Peer reviewer (PR)</b> (>2 per issue). No fee. Many were international experts.	Reads first and second draft and provides written, specific and evidence-based, referenced comments.	Approves list of expert reviewers, can suggest names, checks that their comments have been taken into account appropriately.

<b>Stakeholder reviewer (SR)</b> (No limit). No fee or entry barrier.	Reads second draft and provides written, specific comments. The degree to which they will be taken into account in the final draft depends on the evidence supplied and its credibility.	Checks that stakeholder comments have been taken into account appropriately.
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One hundred and forty six assessment authors were drawn from a broad range of employment backgrounds and from many regions of South Africa, with a range of gender and ethnicities. There was a deliberate effort to ensure diversity and a balance of interests, disciplinary background, experience and perspectives in the team, a process which was overseen by the Custodian Group.

Table 2: The final scope of topic chapters and the composition of the author teams commissioned to generate the content. The FOD was reviewed by nominated national and international peer reviewers. The SOD was reviewed by the same peer reviewers along with a number of stakeholder reviewers. IAs = Integrating Authors; CAs = Contributing Authors; CoAs = Corresponding Authors; PRs = Peer Reviewers; SRs = Stakeholder Reviewers

Ch.	Title	IAs	CAs	CoAs	PRs	SRs
1	Scenarios and Activities	1	11	4	4	8
2	National Energy Planning and Security	1	3	0	4	6
3	Air Quality and Greenhouse Gas Emissions	1	5	0	4	7
4	Earthquakes	1	2	0	4	9
5	Water Resources	2	10	1	7	9
6	Impacts on Waste Planning and Management	1	1	1	5	9
7	Biodiversity and Ecological Impacts	2	5	38	5	15
8	Impacts on Agriculture	1	3	3	4	6
9	Impacts on Tourism in the Karoo	1	3	0	4	6
10	Impacts on the Economy	1	3	1	4	6
11	Impacts on Social Fabric	1	3	2	4	4
12	Impacts on Human Health	1	5	0	4	8
13	Impacts on Sense of Place	1	2	3	4	2
14	Visual, Aesthetic and Scenic Resources	1	3	2	6	3
15	Impacts on Heritage	1	3	5	6	4
16	Noise Generated by Shale Gas- Related Activities	1	1	1	3	4
17	Electromagnetic Interference	1	2	0	2	2
18	Impacts on Integrated Spatial and Infrastructure Planning	2	3	1	2	6
Total		21	63	62	76	114



## 6.4 Participation through review and response

Following approval of the scope of the ZOD by governance groups and stakeholders, the multi-author teams initiated drafting the First Order Draft (FOD) of the assessment. The FOD chapters were submitted to 25 local and 46 international independent experts for peer review. These experts were selected by the management team, with the approval of the governance structures, based on their experience in relation to shale gas development or specific knowledge of the Central Karoo social and ecological systems. Expert reviewers were drawn from government, NGOs, academia, and the private sector, with many international volunteers coming from the United States of America, Canada, Australia and other European countries.

[insert fig 3]

Figure 3: The scientific assessment phase began with Author Meeting # 1 and the production of ZOD, followed by the first draft text, tables and figures in the FOD which was subsequently sent for national and international peer review. Incorporating the comments from the peer review experts, the multi-author teams developed the Second Order Draft (SOD) which was sent back to the peer review experts and simultaneously released to the general public for comment. Based on the feedback from the peer review experts and the general stakeholder comments, the final scientific assessment was published (after Scholes et al., 2017)

Peer and stakeholder review comments were submitted as structured page-and-line numbered statements which evaluated the accuracy, balance and comprehensiveness of the chapter content. The peer review comments were used in development of the content for the Second Order Draft (SOD) and the responses to the comments by the multi-author teams were required to be sufficiently descriptive for the stakeholders to be able to trace them in the text or understand the basis upon which

they had been accepted or rejected. The primary criterion was to demonstrate that multi-author teams had adequately applied their minds in the consideration of the comments from the peer reviewers.

The same peer review experts reviewed the revised SOD which was also released for broader stakeholder review with a second round of public outreach. Before finalisation of the published scientific assessment, the draft findings were presented to the same local and stakeholder communities to check that the key issues had been addressed. Their feedback was incorporated via the review process and facilitated where necessary for stakeholders without access to internet, by capturing verbal input at the public meetings.

## **7 Lessons learned**

It is a common misconception that the decision regarding shale gas development is a binary ‘yes’ or ‘no’. There are a number of decisions to be made, via a number of decision-making processes, across all levels of government and society (including the private sector), over a protracted period of time. Most of these decisions will be conditional rather than absolute, meaning that an action may be permitted in one location and not another, or within a requisite set of management actions to reduce risk.

In South Africa, a democratic country with a strong developmental focus, it is important that public processes are informed by inclusive and deliberative knowledge generation exercises. The success of resource governance in a country which has no experience in domestic onshore oil and gas production is dependent on processes which seek to include broader society in both the generation of knowledge and subsequent decisions made relative to that knowledge.

In the Central Karoo, the biggest challenge is the lack of existing infrastructure and the requisite skills within the private and public sector to manage the shale gas industry in a manner that does not give rise to unacceptable consequences. Thus, the capacity factors limiting the Central Karoo will have to be considered within future site-specific assessments, with practical alternatives or management actions stipulated by the practitioners and applicants. This must provide decision-makers with a clear indication of the trade-off implications associated with each decision option.

The success of site-specific assessments, as was in the case for the national scientific assessment, will depend on the extent to which stakeholders are included in the information gathering and decision-making processes. Additionally, site-specific assessments for exploration must promote the principle of avoidance. It has been demonstrated that even under a relatively intensive exploration scenario, that

there is sufficient physical space in the expanse of the Central Karoo to avoid sensitive social and ecological features (Schreiner and Snyman-Van der Walt, 2018). The relatively small physical footprint associated with shale gas exploration activities, means that there is a high degree of flexibility in the positioning of wellfields, wellpads, roads and other associated infrastructure. This can only be guided by focused assessments which embrace local knowledge.

Decision-making for site-specific assessments will require a step-wise approach, rooted in the concept of adaptive management. In other words, a focus on the importance of baseline and ongoing information for testing both the management actions employed to mitigate undesired outcomes and the assumptions which underpinned those actions. As a starting point, South Africa is in the advantageous position of being able to accumulate such a baseline dataset and start building the institutions capable of collecting, managing and analysing that data in a responsible and transparent manner.

Due to the continuous evolution of the science-policy interface, ongoing research is also required to ensure that environmental policies and regulations keep pace with shale gas development. This is not to suggest that no development should take place until all risk is mitigated to zero. Rather, if South Africa does choose to proceed with shale gas exploration, and assuming an economically suitable reserve is discovered, then the decision-making processes to arrive at that point must be inclusive of society and based on evidence which is broadly considered trustworthy.

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