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Research paper

# Prospective policy safeguards to mitigate hydrogeological risk pathways in advance of shale gas development in the Karoo basin, South Africa

Kevin Pietersen <sup>a</sup>, Luc Chevallier <sup>b</sup>, Audrey Levine <sup>a, c</sup>, Thandokazi Maceba <sup>a</sup>, Zaheed Gaffoor <sup>a</sup>, Thokozani Kanyerere <sup>a</sup>

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## Highlights

• Main hydro-litho-structural domains are defined in the Western Karoo.

• Natural groundwater pathways include regional groundwater flow and shallow discrete features.

• Artificial connection between deep and shallow water can be created.

• Safeguards to protect the quality and availability of local groundwater resources are needed.

## Abstract

Policies surrounding energy development are frequently implemented in response to known or perceived problems. South Africa is in a unique position to develop prospective policies that build on knowledge gained from



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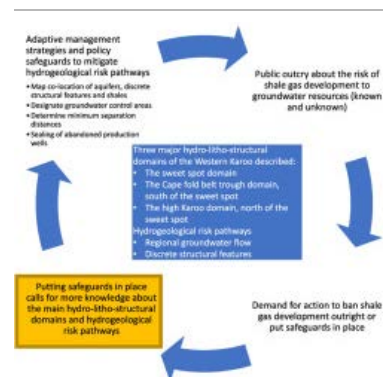
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elsewhere. This paper provides a prospective analysis of hydrogeological risk pathways and vulnerability attributes in advance of anticipated shale gas operations in the Karoo Basin of South Africa. The “hazard-pathways-receptors” approach is applied to define the hydrogeologic system in the context of potential sources of water resource contamination. This case study focuses on two critical hydrogeological risk pathways: regional groundwater flow and discrete structural features. Depending on the targeted area (hydro-litho-structural domain, depth of target, presence of aquitard, intrusion ratio), the capacity of deep natural pathways to enable hydraulic fracturing fluids, chemicals, or produced water to reach shallow groundwater, will be reduced or difficult. Deep artesian water could however be intercepted at different depths and, based on past groundwater exploration in the Karoo, water could flow into horizontal fractures or openings characterising the shallow aquifers: sills-ring complexes, lithological contacts, and transgressive fractures across dolerite dykes. However, above-ground water and wastewater management safeguards are needed to protect shallow groundwater from potential water quality degradation due to a) flowback or produced water b) stray gas and/or c) spills or illicit discharges that could introduce contaminants into groundwater resources. This paper describes a systematic approach to evaluate hydrogeologic risk pathways and informs adaptive management policies to protect South African groundwater resources.

## Graphical abstract



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## Keywords

## Shale gas; Hydrogeologic risk pathways; Karoo basin; Adaptive management policies

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