USAf 2026 Open Call for Societal Impact Case Studies

1. Title of the Impact Case Study

Re-engineering a degraded coalfield wetland into ecological infrastructure: The Zaalklapspruit acid mine drainage passive treatment case

2. Submitting University

University of the Free State (Engineering Sciences; Ecological Engineering Institute of Africa).

3. Name, position and email address of Contact Person for this case study

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4. Summary of the impact

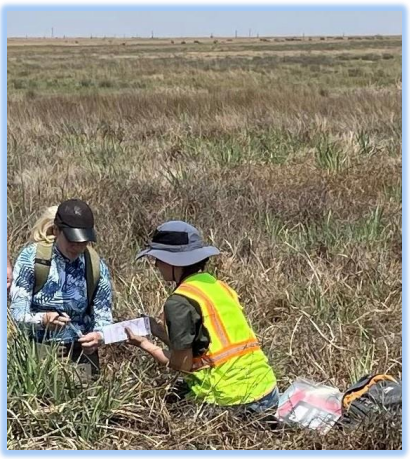
The Zaalklapspruit/Grootspruit wetland in the upper Olifants River catchment, Mpumalanga, is a critically endangered valley-bottom wetland affected by acid mine drainage (AMD) from coal mining. Academic work led through the University of the Free State (UFS), building on the earlier SANBI-CSIR-WRC-Coaltech-Working for Wetlands rehabilitation platform, has converted the site into a field-validated ecological engineering case study for mine-water mitigation.



The impact is not the rehabilitation activity alone, but the demonstrable change (including reinstating ecosystem services) it enabled: improved downstream water quality, strengthened evidence for passive AMD treatment, incorporation of Zaalklapspruit into national wetland rehabilitation and mining-sector cleaner-technology guidance, and improved decision support for regulators, mining companies, water-resource managers and environmental practitioners. Beneficiaries include DWS and related regulatory institutions, the coal-mining sector, WRC/SANBI/Coaltech practice networks, downstream aquatic ecosystems, agricultural water users and communities dependent on better managed catchment services. The case contributes directly to SDGs 6, 9, 13, 15 and 17.

5. Underpinning academic work

The underpinning academic work is an interdisciplinary UFS research programme in ecological engineering, aquatic ecosystem health and mine-water management. It investigated whether engineered rewetting and flow redistribution could restore the water-quality enhancement function of a degraded wetland receiving AMD. Methods included water chemistry, pH, alkalinity, EC, sulphate and metal analysis; periphyton bioindicators; hydrochemical and isotope interpretation; sediment, macrophyte-root and microbial pathway analysis; drought and veldfire response assessment; and ecosystem-service valuation.



The academic contribution extends beyond descriptive characterisation by generating process-based evidence of the coupled hydrological, geochemical and biological mechanisms through which wetland sediments, macrophyte root systems, periphyton assemblages and microbial communities mediate the attenuation, transformation and sequestration of AMD constituents, thereby reducing downstream ecological and water-quality risk.

6. Narrative description of the impact

South Africa's coalfields require solutions that reduce mine-water risk without creating perpetual energy, chemical and sludge liabilities. The Zaalklapspruit case responded to this societal challenge by demonstrating how a degraded wetland can be rehabilitated and monitored as ecological infrastructure. Concrete structures and earthworks slowed and redistributed flow, raised the water table, reduced channelised conveyance and increased contact between AMD-affected water and biologically active wetland compartments over an enlarged treatment area of approximately 9.4 ha.

Significance: The impact is significant because measurable environmental improvement has occurred. WRC evidence reported a 65% reduction in sulphate and 50% reduction in total dissolved solids compared with pre-rehabilitation values. Subsequent Coaltech/UFS monitoring showed sulphate declining from a median of 1328 mg/L at the inflow to 254 mg/L at the outflow, alkalinity increasing to 128 mg/L, and EC decreasing between inflow and outflow. DWS's 2026 Cleaner Technology Options report further cites Zaalklapspruit as a practical UFS-implemented AMD treatment example, reporting five-year average reductions of sulphate, Al, Fe and Mn, and stating that lessons from the wetland can inform constructed surface-wetland development.

The impact is also economic and governance-related. Ecosystem-service valuation estimated the wetland's water purification and waste-assimilation service at R2.6-R11.4 million per year, and its ecological-infrastructure asset value at R501-R763 million, compared with a rehabilitation cost of R1.7 million. This reframes wetlands from marginal environmental assets into decision-relevant public-good infrastructure for catchment resilience, mine-closure planning and water-quality risk reduction.

Reach: The impact reaches multiple beneficiary groups rather than a single academic audience. The Zaalklapspruit passive-treatment approach is included as Box 7 in the national guide Wetland Rehabilitation in Mining Landscapes: An Introductory Guide (Macfarlane et al., 2016; WRC Report TT 658/16; WRC Project K5/2230/3), where it is presented as a case study of rehabilitating a wetland subject to AMD impacts. This gives the case national practice reach beyond the original site. The guide records that the Zaalklap project tested standard Working for Wetlands rehabilitation techniques to address mining-related impacts on wetlands, ecosystem services and water resources, including mining-related water quality. The Gazette reference supplied for the institutional evidence pack is Government Gazette, 24 March 2017, No. 407/3.

Additional reach is demonstrated through DWS mining-sector cleaner-technology guidance, WRC/SANBI/Coaltech practitioner learning, Water Wheel public communication on ecological infrastructure, and use by consultants and mine-water managers considering passive treatment and nature-based engineering. The reach is therefore sectoral and institutional: regulators, mining houses, practitioners, catchment managers and downstream beneficiaries can use the evidence when assessing AMD mitigation, licensing, rehabilitation and closure options.



The case also improved practice by showing limits and resilience thresholds. Drought research showed a loss of wetland function and a minimum two-year recovery period after severe drought, while veldfire research showed that disturbance can alter treatment pathways through ash slurry, macroalgal mats and changed flows. The resulting practice message is mature and implementable: ecologically engineered wetlands are powerful low-energy systems, but they require adaptive monitoring, realistic loading assumptions and integration with broader catchment pollution control.

7. Evidence and sources to corroborate the impact

Quantitative performance evidence: WRC Report 2230/2/16 documented post-rehabilitation water-quality improvement, including sulphate and TDS reduction. Coaltech/UFS monitoring reported median sulphate reduction from 1328 mg/L to 254 mg/L, increased alkalinity and reduced EC from inflow to outflow. Peer-reviewed evidence includes Oberholster et al. (2022, Processes 10, 877), Jansen van Vuuren et al. (2024, Applied Sciences 14, 7441) and Oberholster et al. (2025, Processes 13, 3494).

Documentary/practice evidence: Macfarlane D., Dlamini B., Marneweck G., Kassier D., Campbell J., Young A., Dini J.A., Holness S.D., de Klerk A.R., Oberholster P.J. and Ginsburg A. (2016). Wetland Rehabilitation in Mining Landscapes: An Introductory Guide. Water Research Commission, Pretoria. WRC Report TT 658/16; WRC Project K5/2230/3. Box 7 presents the Zaalklapspruit AMD rehabilitation case study and records positive water-quality and economic outcomes. DWS (2026) Cleaner Technology Options for Improvement of Water Quality in South Africa: Mining Sector includes constructed wetlands as a cleaner-technology option and identifies Zaalklapspruit as a practical UFS-implemented AMD treatment example.

Independent/media and stakeholder evidence: The Water Wheel article (2014, pp. 21-25) documents the public-private partnership among CSIR, SANBI, Working for Wetlands, WRC and Coaltech, the rehabilitation intervention, early improvements in pH and dissolved metals, and the broader value of passive wetland systems for post-mining landscapes.

Presentation of guideline as co-author – Constructed and Ecologically Engineered Wetlands Guidelines for South Africa for Water Use Authorisation in terms of Impacts on Characteristics of Watercourse: https://iaiasa.co.za/wp-content/uploads/2025/09/Y-Schoeman-_Constructed_Wetlands_Guidelines_Presentation-300725-.pdf

8. Any other information considered relevant

SDG alignment: SDG 6.3 and 6.6 (water quality and wetland protection), SDG 9.4 (sustainable infrastructure and cleaner technologies), SDG 13.1 (resilience to drought and fire disturbance), SDG 15.1 and 15.5 (terrestrial and freshwater ecosystem protection), and SDG 17.16 (multi-stakeholder partnership). The case is submitted as a societal-impact case: the impact lies in changed evidence use, practice guidance, environmental performance, risk reduction and decision support beyond academia.