

Perspectives on the future of waste management in South African protected areas

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Introduction and problem statement



Protected areas under pressure

- Protected areas (PAs) play a central role in biodiversity conservation and ecosystem services (Solomon *et al.*, 2013; Mitchell *et al.*, 2018).
- Simultaneously, PAs support tourism-dependent economic activity (Manzoor *et al.*, 2019).
- Increasing visitor numbers and infrastructure expansion create governance tensions (Sandbrook *et al.*, 2019; Lindsey *et al.*, 2020).
- Waste is an unavoidable by-product of tourism and park operations, yet remains underexamined in conservation governance.

Why waste management matters for conservation?

- Poor waste management can:
 - Cause biodiversity impacts and wildlife habituation
 - Lead to plastic pollution and ecosystem degradation.
 - Undermine visitor experience and park reputation.
- In developing country contexts, waste systems often face capacity and infrastructure constraints (Nyaupane *et al.*, 2020).
- Waste management is therefore both an operational and governance challenge.



Waste management research in protected areas

- South African research has focused on challenges and opportunities, behavioural drivers and policy integration.

- Largely retrospective, with no focus on future scenarios.



Applying the Theory of Planned Behaviour to Tourism-Related Waste Behaviour in Marine Protected Areas: The Aliwal Shoal Case Study

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Challenges and opportunities for sustainable solid waste management in private nature reserves: The case of Sabi Sand Wildtuin, South Africa

Abstract: The management of waste in protected areas may lead to significant and irreversible environmental, economic and social impacts, such as land degradation, resource depletion, surface and groundwater pollution, loss of biodiversity and impacts on the aesthetic value of these areas. This paper aims to identify the challenges and opportunities for sustainable solid waste management in privately protected areas, given the limited research conducted on this topic. A case study approach was followed, which focused on the Sabi Sand Wildtuin, a private nature reserve (PNR) in South Africa. Interviews were conducted with 30 participants, which included representatives from the management authority, commercial lodges, non-commercial properties and a waste service provider. Several challenges have been identified by interviewees. Behaviour was the most frequently mentioned challenge, where interviewees raised concerns about negative attitudes, unwillingness to implement waste management measures and a possible lack of support. Other frequently mentioned challenges included increased difficulties due to the size and location of the preserve and concerns around funding of waste management measures, especially given the financial implications of coronavirus disease 2019 (COVID-19) travel and tourism restrictions. The most frequently identified opportunities included creating jobs and improving livelihoods, providing awareness and transparency of what happens to waste 'beyond the gate' and improving awareness, knowledge and skills related to waste management. To optimise the opportunities towards sustainable solid waste management, PNRs should focus on aligning their strategic direction to achieve legal compliance and support community initiatives to establish waste-related infrastructure and services that cannot be implemented within the reserve.

Conservation implications: The pursuit of waste-related opportunities within privately protected areas could enhance the implementation of sustainable solid waste management in PNRs, whilst also contributing to pollution prevention, community upliftment and other secondary benefits, which could ultimately result in increased conservation efforts.

Keywords: sustainable solid waste management, protected areas, private nature reserves, challenges, opportunities, Sabi Sand Wildtuin.

Introduction
Protected areas are of international importance due to their natural, historical, cultural and economic value (Alberts et al. 2021; Sandbrook et al. 2019). Economies in protected areas has rapidly increased globally, which has several adverse impacts, including increased waste generation (Rodriguez-Rodriguez 2012). The mismanagement of waste in protected areas may lead to significant and irreversible environmental, economic and social impacts, such as land



Key words: attitudes, intent, willingness, support, protected areas, South Africa

INTRODUCTION
Protected areas are increasingly expected to generate tourism revenue and deliver resilient community benefits, placing increased development pressure on already threatened and sensitive environments (Sandbrook et al. 2019). One specific concern with increased development within protected areas is effective waste management (Steg & Vlek, 2009; Sandham et al. 2020). The negative impacts of waste on protected areas are well-known (Przydatek, 2019), affecting conservation efforts, adjacent communities, and visitor experience (Dorison-Saunders et al. 2015; 2016a; 2020). The research by Dorison-Saunders et al. (2015), which focused on understanding expectations for responsible tourism in protected areas, indicated that visitor expectations for waste management included:

- Consideration of the "waste management hierarchy" and the "circular economy"; and
- Improving "awareness" of visitors around waste management practices.

The need to sit (public) waste management practices. Potentially, private reserves (PNRs) protected areas. Potentially, private reserves (PNRs) protected areas. Potentially, private reserves (PNRs) protected areas.

Research aim

- To explore perceived ***future trajectories*** of waste management in South African national parks.
- Move beyond retrospective analysis through a futures-oriented governance lens (Börjeson *et al.*, 2006; Chermack, 2011).
- Inform SANParks Vision 2040 planning processes and SANParks Integrated Waste Management Strategy.



Case study context: South African national parks

- Project scope: 21 National parks managed by South African National Parks.
- Mix of high-volume flagship parks and remote, resource-constrained parks.
- Diverse waste service arrangements: municipal collection, self-transport, and on-site processing.
- No formally approved park-specific Integrated Waste Management Plans at time of study.





Methods

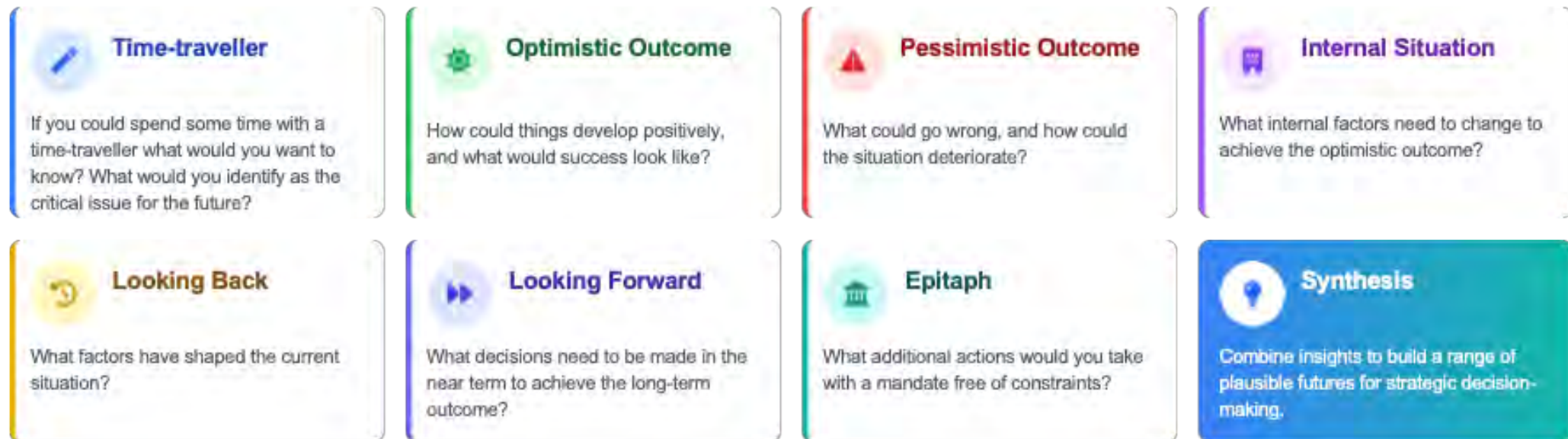
Methodology (1)

- **Protected area management plan review**
 - To determine the extent to which protected area management plans address waste management
- **Site verifications**
 - 19 national parks assessed (2024–2025)
 - Focus on tourism-facing infrastructure and processes
 - Observational indicators:
 - Bin availability and condition
 - Wildlife-proofing measures
 - Cleanliness and containment
 - Separation-at-source infrastructure
 - Diversion/minimisation practices
- Three-point rating scale (A–C): Good, moderate and poor integration/implementation.

Methodology (2)

- **Interviews**

- Semi-structured interviews (managers, sustainability staff, scientists, hospitality) (n = 13).
- Applied the UK Government's *Seven Questions* foresight framework.
- Inductive thematic analysis to identify cross-cutting drivers.



Methodology (3)

- **Scenario development**

- Informed by site verification (status quo) and themes from interviews
- Optimistic, realistic, pessimistic
- 25-year horizon, towards 2040 in alignment with SANParks' *Vision 2040*

Results



Current status: Operational strengths

- High levels of cleanliness across visitor areas in most national parks.
- Most parks have extensive bin networks and visible containment infrastructure.
- Examples of innovation:
 - Organic waste diversion (e.g., composting; Black Soldier Fly larvae systems – Diener *et al.*, 2009): Tankwa Karoo national park
 - “Carry-in, carry-out” systems in remote picnic areas (Marion & Reid, 2007): Kgalagadi, Mokala and Mountain Zebra national parks
 - Waste separation initiatives at Kruger National Park picnic sites in collaboration with PROs
 - Problematic plastics policy being developed
- Indicates baseline operational competence.

Current status: Gaps and systemic weaknesses

- Principles for responsible waste management is poorly integrated into protected area management plans.
- Separation-at-source infrastructure weakest-performing indicator.
- Inconsistent wildlife-proofing → risk of animal habituation and human-wildlife conflict (Herrero *et al.*, 2005).
- Uneven implementation across parks.
- Reactive, operational focus rather than strategic integration.
- Fragmented monitoring and limited performance reporting (Wilson *et al.*, 2015; UNEP, 2021).
- Operational adequacy does not equal strategic resilience.

Key drivers of future trajectories

Theme	Core issues identified	Representative participant perspectives	Frequency (n = 13)
Institutional and resource capacity	Lack of dedicated staff, equipment, infrastructure, transport and budgets for waste management	Waste management is under-resourced and treated as an afterthought despite increasing visitor numbers	11
Behavioural and cultural mindsets	Poor compliance by staff and visitors; lack of interest, ownership and accountability	Infrastructure exists but is undermined by inappropriate use and a “not my responsibility” culture	8
Leadership and strategic priority	Limited senior management commitment; waste not viewed as core business	Change is perceived to stall due to insufficient top-down support and strategic direction	6
Circular economy integration	Limited implementation of waste reduction, recycling and composting initiatives	Strong conceptual support exists, but practical constraints hinder system-wide adoption	6

Institutional capacity as the dominant driver

- 85% of interviewees highlighted staffing and budget constraints.
- Waste often treated as an “add-on” rather than core function.
- Tourism growth not matched by proportional waste system expansion.
- Reflects governance-implementation gap common in waste systems (Guerrero et al., 2013; Wilson et al., 2015).
- Without targeted investment → risk of reinforcing unsustainable path dependency.

Behaviour, culture and leadership as enablers and barriers

- Infrastructure undermined by:
 - Visitor non-compliance
 - Organisational disengagement
- Behavioural factors critical for recycling performance (Barr et al., 2003; Nuojuu et al., 2024).
- Leadership determines:
 - Strategic priority
 - Resource allocation
 - Accountability mechanisms (Ferdig, 2007).
- Waste management outcomes depend on institutional culture as much as infrastructure.

Circular economy as transformative opportunity

- Participants envision the possibility of a future of “transformative circularity”:
 - Near-zero waste to landfill
 - Standardised source separation
 - Organic waste valorisation
- Requires:
 - Decentralised infrastructure
 - Market linkages
 - Partnerships
 - Monitoring systems
- Transition depends on governance consistency, not technological breakthroughs.

Future scenarios and conclusions





Optimistic

Transformative Circularity (*Blue Skies*)

- Leadership:** Strong commitment with adequate resources
- Circular economy:** Comprehensive waste reduction, reuse, recycling
- Ecological:** Pollution prevention, healthy ecosystems

Waste reduction

Renewable energy

Zero loss of containment



Realistic

Incremental Adaptation (*Glass half*)

- Mixed progress:** Partial implementation with successes and limitations
- Improvements:** Selected parks receive upgrades, some staff trained, some partnerships/stakeholder engagement
- Challenges:** Inconsistent funding, infrastructure development delays

Gradual improvement

Moderate investment

Stakeholder engagement



Pessimistic

Systemic Decline (*Doom and gloom*)

- Leadership:** Disengagement, lack of interest, funding cuts, ineffective management
- System:** Infrastructure collapses, unregulated dumping, visitor impacts, reputational damage
- Environment:** Increase in pollution and litter, ecosystem damage, irreversible harm

Increase in waste generation

Habitat degradation

Visitor impacts, reputational damage

Key Factor Comparison

Aspect	Optimistic	Realistic	Pessimistic
 Funding	Adequate and sustainable	Limited but sufficient	Insufficient, declining
 Infrastructure	Modern, eco-friendly	Mixed condition	Poor, aging, inadequate
 Ecological	Thriving ecosystems	Mixed impacts	Degraded habitats



Key Insight: Institutional and resource capacity, behavioural changes and leadership commitment are the primary perceived determinants of future waste management outcomes.

Scenario 1: Optimistic “blue skies”

- Transformative circularity by 2040
 - Waste embedded as core conservation function.
 - Dedicated waste governance roles and budgets.
 - Strong leadership and positive waste culture.
 - Effective wildlife-proof infrastructure.
 - Near-zero waste to landfill.
- Aligned with circular transition principles (Oberč et al., 2022).
High upfront coordination and investment required.

Scenario 2: Realistic “glass half”

- Incremental adaptation by 2040
 - Gradual improvement in flagship parks.
 - Continued landfill reliance in remote parks.
 - Uneven separation systems.
 - Moderate waste reduction but limited systemic reform.
- Risk: stagnation under budget or market setbacks (UNEP, 2021).
Requires system-wide coordination and performance monitoring.

Scenario 3: Pessimistic “doom and gloom”

- Systemic decline by 2040
 - Rising tourism pressure coupled with weak leadership, lack of interest, poor organisational culture and negative human behaviour.
 - Infrastructure deterioration.
 - Wildlife-waste conflict intensifies.
 - Plastic pollution spreads to rivers and oceans (Bergmann et al., 2019).
 - Reputational and ecological damage.
- Recovery becomes increasingly costly if preventative governance fails.



Conclusions

- Waste management is at a governance crossroads.
- Current system = operationally functional but strategically vulnerable.
- Future depends on:
 - Leadership prioritisation
 - Institutional capacity
 - Behavioural change
- Sustainability transitions literature confirms that governance alignment determines long-term system performance (Geels, 2011).



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 - Strengthened SANParks–university collaboration.
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