

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



Authors:

Claudine Roos¹ 
 Reece C. Alberts¹ 
 Francois P. Retief¹ 
 Dirk P. Cilliers¹ 
 William Hodgson² 
 Iain Olivier² 

Affiliations:

¹Unit for Environmental Sciences and Management, Faculty of Natural and Agricultural Sciences, North-West University, Potchefstroom, South Africa

²Sabi Sand Pfunanani Trust, Sabi Sand Wildtuin, Skukuza, South Africa

Corresponding author:

Claudine Roos,
claudine.roos@nwu.ac.za

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The mismanagement 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 foreseen difficulties due to the size and location of the reserve 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 assurance 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 ecotourism value (Alberts et al. 2021; Sandbrook et al. 2019). Ecotourism in protected areas has rapidly increased globally, which has several adverse impacts, including increased waste generation (Rodríguez-Rodríguez 2012). The mismanagement 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 tourism locations (Dunjić et al. 2017; Steg & Vlek 2009).

Hong and Chan (2010:140) have identified solid waste management as the 'most severe threat' affecting Penang National Park in Malaysia. This was mainly due to the irresponsible disposal of waste, absence of formal waste management policies and systems and limited environmental and waste-related awareness amongst visitors. In South Africa, research by Du Plessis, Van der Merwe and Saayman (2013) which focused on tourists' perceptions on the environmental friendliness of South African national parks found that 'waste management and the recycling of waste in national parks require attention'.

Sustainable waste management is suggested as an important component of sustainable ecotourism indicator and rating systems (Li 2004; Van der Merwe, Saayman & Bothma 2017), and it also ranks

amongst the top responsible tourism expectations of visitors to national parks (De Witt 2015; Du Plessis et al. 2013; Morrison-Saunders et al. 2019).

Chang and Pires (2015) argue that the adverse impacts of waste can be mitigated, or entirely avoided, through sustainable solid waste management. *Sustainable solid waste management* is explained as the management of waste in such a manner that 'resources are sufficient to fulfil the demand for daily consumption whilst guaranteeing ecosystem sustainability by using appropriate waste collection, handling, reuse, recycling and resource conservation' (Chang & Pires 2015:12), whilst also providing for multiple triple bottom line dimensions, including social, environmental and economic aspects (Yadav & Karmakar 2020).

Limited research has been done on the challenges and opportunities of achieving sustainable solid waste management in protected areas, specifically within the developing country context (Przydatek 2019). To this end, this paper aims to identify the challenges and opportunities for sustainable solid waste management in privately protected areas, following a case study approach by focusing on a private nature reserve (PNR) in South Africa. Mitchell et al. (2018) and Przydatek (2019) highlight the importance of privately protected areas such as PNRs in contributing to conservation and protected area strategies, whilst the importance of responsible waste management in PNRs has been highlighted by Roos et al. (2021).

This research builds on the work of Roos et al. (2021) that investigated waste behaviour in PNRs through the application of the theory of planned behaviour, using a South African PNR, Sabi Sand Wildtuin (SSW), as a case study. This research employed surveys where ordinal scales were used to indicate the level of agreement or disagreement with waste behaviour and practice statements. The study did not investigate the reasons for specific responses; follow-up research was thus recommended by the authors. The scope of this research therefore expands on the initial research of Roos et al. (2021) by identifying challenges and opportunities for sustainable solid waste management in PNRs.

Research methods and design

This research follows an exploratory research design following a case study approach. Qualitative data was collected by conducting interviews with various waste management stakeholders within a selected South African PNR. Purposive sampling was used to target the respondents who participated in the earlier survey done by Roos et al. (2021).

The case study: Sabi Sand Wildtuin

The SSW was considered as a suitable case study to explore challenges and opportunities for sustainable solid waste management in PNRs because it is a well-established PNR and the management authority is currently in the process of

developing an integrated waste management strategy for the reserve. Understanding the challenges and opportunities for waste management, as perceived by different stakeholders, would provide valuable insights towards implementation of this strategy.

The SSW, which is located in the Greater Kruger National Park, is the oldest private game reserve in South Africa (Figure 1), with internationally recognised high-end luxury tourist products and infrastructure resulting in waste management challenges (Roos et al. 2021). The reserve includes 24 commercial properties with lodges and 30 non-commercial private properties. A total of 32 lodges are located on the commercial properties. The estimated total amount of waste generated by SSW per year is approximately 180 tonnes and consists of mainly general waste (such as plastic, glass, paper and packaging and metals) and organic waste (such as food waste and garden waste), with limited quantities of hazardous waste being generated.

Data capturing and analysis

Semi-structured face-to-face interviews were administered in April to July 2021. Two questions were posed during the interviews: (1) What are the challenges for solid waste management in the SSW PNR? (2) What are the opportunities for solid waste management in the SSW PNR? Interviews lasted approximately 45 min to 1 h and were conducted with 30 participants. They included the following:

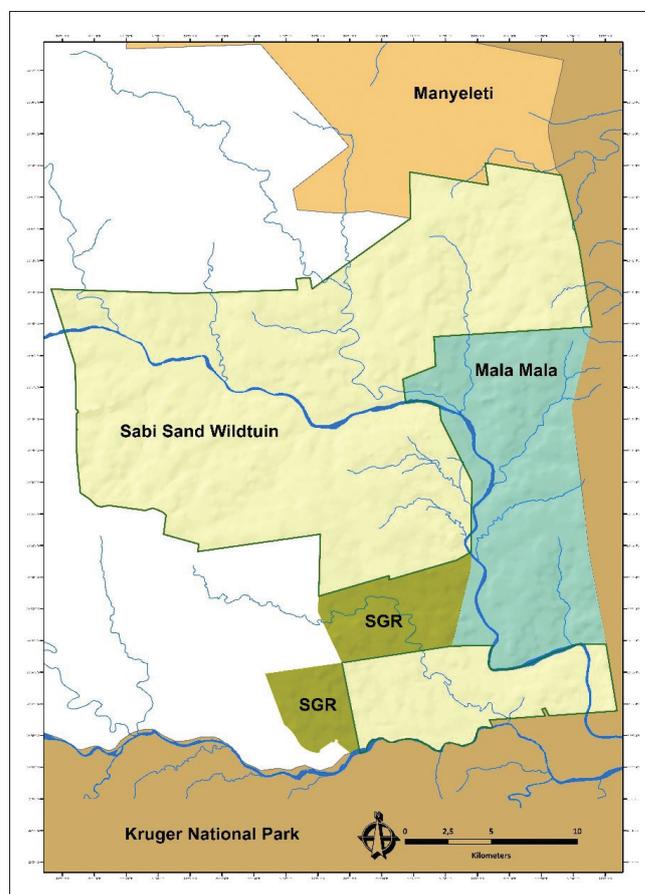


FIGURE 1: Sabi Sand Wildtuin in South Africa.

- eleven members of the management authority
- representatives from 13 of the commercial lodges
- representatives from five non-commercial private properties
- one of the two waste service providers rendering services to SSW.

These participants represent approximately 50% of the total population of management authority, commercial property and non-commercial property members of the SSW.

The research was subjected to ethics approval and was classified within the minimal risk category. No vulnerable communities, children or incapacitated adults were included in the interviewee sample. All participants were informed of the interview procedure and their right to withdraw from the interview. Interviewees were required to provide informed consent prior to commencement of the interview. Results are presented anonymously.

Voice recorded interviewee responses were transcribed. The framework suggested by Mwangi and Thuo (2014) for conceptualising and identifying problems, challenges and mechanisms for waste management in developing countries informed the categorisation of responses. The framework provides for (1) technical, (2) financial and economic, (3) social and cultural, (4) environmental health, (5) institutional and political and (6) legal and policy categories. This framework was ideally suited for the categorisation of responses based on the research scope and the type of responses expected during the interview.

Responses were thematically analysed through coding (C1 to C18 in Table 1; O1 to O19 in Table 2) and deductive reasoning (Braun & Clarke 2006:79). This process involved familiarisation with the data, generation of initial codes and finally collating of codes into themes according to the categories proposed by Mwangi and Thuo (2014). Because the number of respondents per stakeholder group are too small to attempt to draw associations or conclusions between statements of the individual stakeholder groups, the responses of all stakeholder groups were consolidated. Responses were ranked based on their frequency of mention, and the 10 most frequently mentioned challenges and opportunities across the themes are highlighted in Tables 1 and 2, respectively.

Ethical considerations

The Faculty of Natural and Agricultural Sciences Ethics Committee (FNASREC) approved this study and the North-West University Senate Committee for Research Ethics (NWU-SCRE) granted its permission for the study to be initiated, using the reference number NWU-00500-21-A9.

Results

Challenges for sustainable solid waste management

The perceived challenges for sustainable solid waste management mentioned by interview respondents are outlined in Table 1.

Opportunities for sustainable solid waste management

The perceived opportunities for sustainable solid waste management mentioned by interview respondents are outlined in Table 2.

Discussion

Sustainable solid waste management challenges

Table 1 outlines the perceived challenges for sustainable solid waste management, as identified by interviewees. According to the four identified themes (A–D in Table 1), key findings are discussed below.

Institutional and financial challenges

Financial provision for waste management (C1) was noted by 43% of participants and was ranked as the third most frequently mentioned challenge for sustainable solid waste management (Table 1). This finding agreed with what other authors (Przydatek 2019; Rodríguez-Rodríguez 2012) have found for protected areas, where insufficient funds and inadequate budget provision were regarded as two of the most significant challenges for sustainable waste management. Interviewees were sensitive towards the costs related to waste management, especially considering the financial strain that the lodges have suffered due to coronavirus disease 2019 (COVID-19) tourism-related restrictions. One of the participants reported that:

‘We are prepared to pay for waste management, but it should not be prohibitively expensive. We cannot pay much more than we are paying now given our financial situation due to COVID-19 restrictions.’

The challenges related to COVID-19, conservation and ecotourism were also highlighted by Lindsey et al. (2020).

Insufficient human resources and capacity (C2) were ranked as the fourth most mentioned challenge (mentioned by 40% of interviewees). Coetzee and Nell (2019) agree that inadequate human resources may hinder the implementation of sound waste management measures in protected areas.

Approximately one third of the participants indicated that waste management is not a business priority (C3). This code was ranked as the seventh most frequently mentioned challenge. Interviewees indicated that waste is often ‘not prioritised’ because it does not form part of the ‘core business of the reserve’. Participants also indicated that they perceived certain waste management activities as ‘inconvenient to guests’ and that they ‘did not want to impact negatively on the ecotourism experience of visitors to the reserve’.

The eighth most frequently mentioned challenge was inadequate municipal support and a lack of service delivery (C4), which 30% of participants highlighted. The SSW PNR relies on private waste collection and transportation services, whilst the adjacent communities are largely reliant on municipal services. Inadequate municipal services have been highlighted as one of the biggest challenges towards effective

TABLE 1: The number (and percentage out of a total of 30 participants) of responses per code as it relates to the perceived challenges for sustainable solid waste management in the private nature reserve.

Sub-category	Phrases	Frequency	
		<i>n</i>	%
Theme A: Institutional and financial challenges			
(C1) Financial provision for and funding of waste management ^{3*}	'cost', 'funds', 'expensive', 'lawful disposal costs money', 'legal liability for unlawful management of waste', 'cost-effective services', 'cost-benefit analysis', 'business case'	13	43
(C2) Insufficient human resources and capacity ^{4*}	'limited resources', 'capacity', 'capacity constraints', 'human resources'	12	40
(C3) Waste not being a business priority ^{7*}	'not a priority', 'not core business', 'waste management requirements against visitor expectations', 'not acceptable to inconvenience guests'	10	33
(C4) Inadequate municipal support and a lack of service delivery ^{8*}	'lack of municipal services', 'no municipal waste collection', 'municipal service delivery', 'no waste collection', 'infrequent services to communities', 'private versus municipal services'	9	30
(C5) Insufficient awareness, knowledge and skills	'lack of knowledge or skills', 'lack of awareness', 'ignorance', 'illiteracy', 'business skills'	8	27
(C6) Limited justification for a business case	'market', 'demand', 'profitability', 'value of waste as a product', 'low economies of scale', 'no incentive', 'no business case'	6	20
(C7) Time and timing challenges	'time associated with waste separation at source', 'timing of waste-related projects within COVID-19', 'too time consuming'	5	17
Theme B: Technical and operational challenges			
(C8) Separated waste being mixed during transportation ^{5*}	'separated waste being mixed', 'transported together', 'wasted effort to separate waste'	11	37
(C9) Inadequate infrastructure, machinery and equipment	availability of: 'infrastructure', 'machinery (vehicles)', 'equipment', 'technologies', 'alternatives to landfilling'	8	27
(C10) Inadequate services to manage certain waste streams	'waste items', 'uncommon waste items', 'bulky waste', 'hazardous waste', 'nappies are a massive problem', 'vehicle batteries', 'fluorescent tubes', 'suppliers being unwilling to take back packaging'	8	27
(C11) Limited standardisation of waste management requirements	'standardisation', 'flexibility', 'diversity', 'lodge-specific initiatives', 'fragmentation'	6	20
(C12) Insufficient and infrequent waste collection services	'frequency of collection', 'reliable collection schedule', 'consistency of waste management services', 'nuisance due to waste piling up'	5	17
(C13) Insufficient data and information on waste quantities and management	'insufficient data', 'no baseline', 'limited information'	3	10
Theme C: Social and cultural challenges			
(C14) Challenging behaviour (attitudes, willingness and buy-in or support) ¹	'aversion', 'do not want to change', 'reluctance', 'negative attitude', 'unwilling', 'changing existing behaviour', 'changing current practice', 'buy-in', 'community participation', 'landowner support', 'poor cooperation'	27	90
(C15) Creating unrealistic expectations of what SSW could reasonably contribute in respect of waste management ^{10*}	'unrealistic expectations', 'managing expectations', 'what SSW can reasonably contribute', 'scope of support'	9	30
(C16) Challenges related to community conflicts and competition	'community infighting', 'competition', 'conflict', 'community politics', 'equal opportunities'	8	27
Theme D: Challenges due to the characteristics of the reserve			
(C17) Challenges related to the location and size of the reserve, compatibility of waste options with protected area expectations, prevention of animal access, etc. ^{2*}	'animal access', 'fit for purpose', 'location of the reserve', 'distance from reserve', 'size of the reserve', 'certain activities are incompatible with the reserve', 'impacts on the greater Kruger area', 'acceptable practice for protected areas'	20	67
(C18) Unavailability of land for waste-related activities and infrastructure (within the reserve) ^{6*}	'no land', 'availability of land', 'no space available', 'cannot use conservation land'	11	37

SSW, Sabi Sand Wildtuin.

†, The top 10 challenges (in terms of frequency of responses) are indicated.

waste management in South Africa in the 2018 State of Waste Report (Department of Environmental Affairs [DEA] 2018). Insufficient waste collection services lead to littering and illegal disposal or dumping of waste in adjacent communities. It leads to pollution and undesirable aesthetic impacts, resulting in negative experiences of reserve visitors. It was therefore not surprising that the participants considered creating cleaner communities (O16) to be one of the most significant opportunities related to waste management.

Insufficient awareness, knowledge and skills (C5), limited justification for a (waste-to-worth) business case (C6), and time and timing challenges (C7) were also noted by interviewees (Table 1). Challenges related to 'time' referred to the amount of time that waste management actions such as separation at source may take up, whilst 'timing' referred to poor timing of required waste management actions, caused by restrictions to ecotourism and travel due to the COVID-19 pandemic.

Technical and operational challenges

Code C8, which related to separated waste being mixed during transportation, was mentioned by 37% of the interviewees. An interviewee stated that 'we have tried to implement waste separation at our lodge, but all of the waste ends up being mixed again when it is transported together'. Lubanova and Maksanova (2020) have also highlighted the ineffective separation of waste as one of the main challenges facing ecotourism resorts and national parks, respectively.

Other technical and operational challenges perceived by participants included:

- inadequate infrastructure, machinery and equipment (C9)
- inadequate services to manage certain waste streams (C10)
- limited standardisation and coordination of waste management requirements (C11) within the reserve

TABLE 2: The number (and percentage out of a total of 30 participants) of responses per code as it relates to the perceived opportunities for sustainable solid waste management in the private nature reserve.

Themes and codes	Phrases	Frequency	
		<i>n</i>	%
Theme A: Institutional and legal or policy opportunities			
(O1) Providing assurance and transparency ^{2*}	'assurance', 'beyond the gate', 'waste going outside the reserve', 'paper trail', 'waste manifest', 'end of life', 'closing the loop', 'having confidence', 'trusting that it is done effectively', 'transparency', 'cradle to grave'	20	67
(O2) Providing strategic direction and standardisation ^{7*}	'alignment with group vision', 'long-term strategy', 'plan', 'having common goals or purpose', 'standardised requirements', 'benchmarking', 'corporate policy expectations'	13	43
(O3) Improving reputation, brand and marketing opportunities ^{9*}	'reputation', 'marketing', '(green) image', 'known as a premium reserve', 'pioneers', 'flagship', 'branding'	12	40
(O4) Providing coordinated, reliable, efficient and effective waste services ^{10*}	'coordinated waste services', 'efficient services', 'effective waste services', 'Management authority (MA) supporting land owners to achieve waste services', 'reliable services'	10	33
(O5) Contributing towards legal compliance	'meeting legal requirements', 'environmental compliance', 'compliance to green assessment requirements'	8	27
(O6) Improving monitoring, collection and recording of data and improving communication and reporting (of waste data)	'waste data', 'knowing what we generate and how we improve', 'improved follow-up, communication and reporting'	8	27
(O7) Providing business opportunities within SSW	'making money from waste', 'waste as a business opportunity', 'cost-saving', 'business case'	6	20
Theme B: Environmental health and ecotourism opportunities			
(O8) Protecting and preserving the environment (as part of ethical and moral obligations) ^{6*}	'conservation ethics', 'protection of the environment', 'moral', 'doing the right thing', 'responsibility', 'obligation', 'responsible care'	13	43
(O9) Meeting visitor expectations ^{8*}	'visitor expectations', 'guest requirements', 'visitor perceptions around waste', 'guest satisfaction with waste management'	12	40
(O10) Addressing visual and aesthetic impacts	'visual impacts', 'aesthetic impacts', 'sense of place', 'disruptive'	8	27
(O11) Preventing pollution	'pollution', 'prevent pollution'	5	17
(O12) Contributing to sustainable environmental management	'sustainability', 'from an environmental point of view', 'sustainable environmental management'	3	10
Theme C: Social and cultural opportunities (with a focus on SSW and surrounding communities)			
(O13) Creating jobs and contributing towards livelihoods ^{1*}	'job creation', 'local job opportunities', 'community benefits', 'creating employment outside tourism activities', 'livelihoods', 'SMMEs', 'giving back to communities', 'improving quality of life', 'partnerships'	23	77
(O14) Improving awareness, knowledge and skills regarding waste management ^{3*}	'awareness', 'education', 'sharing knowledge', 'improving waste management skills', 'mentoring', 'business skills'	17	57
(O15) Contributing to community support and upliftment ^{5*}	'community relations', 'community projects', 'community upliftment', 'supporting communities', 'working with communities'	15	50
(O16) Creating cleaner communities	'cleaner surrounding community', 'address littering in the community', 'lack of municipal services outside the gate', 'helping communities to manage waste'	13	43
Theme D: Technical opportunities (Alternatives to landfilling)			
(O17) Implementing the waste management hierarchy (avoid, separation at source, reduce, re-use, recycle) ^{4*}	'avoid', 'reduce', 'recycle', 'separate at source', 'separation', 'buy-back centre', 'waste management hierarchy'	17	57
(O18) Composting	'composting', 'garden waste recycling through composting'	6	20
(O19) Waste-to-energy	'waste-to-energy', 'organic waste streams', 'biogas'	3	10

SSW, Sabi Sand Wildtuin.

*The top 10 opportunities (in terms of frequency of responses) are indicated.

- insufficient and infrequent waste collection services (C12) by private waste service providers
- insufficient data and information on waste quantities and management (C13).

These are common issues for waste management within the South African and developing country contexts, also highlighted by authors such as De Witt (2015) and DEA (2018).

Social and cultural challenges

The most frequently mentioned challenge related to sustainable waste management, raised by 90% of participants, was code C14, challenging behaviour. Waste-related behaviour plays a significant role towards integrated waste management in PNRs (Roos et al. 2021). Negative attitudes, perceived behavioural control elements, unwillingness to engage in waste management activities and a lack of support for waste management activities could all contribute to poor waste management behaviour and unsound waste management practices in protected areas (Chen et al. 2020).

In the context of the SSW PNR, interviewees raised concerns regarding 'aversion and reluctance to implement waste management practices', 'role players not being willing to change behaviour and practice', 'negative attitudes towards waste' and 'a lack of buy-in and support from role players', as well as poor 'community participation', 'landowner support' and 'insufficient cooperation'. Similarly, Ogato (2014) identified poor culture, attitudes and habits of different role players in protected areas towards pollution control and waste management as one of the significant challenges impacting on sustainable ecotourism development in Addis Ababa, Ethiopia.

Code C15 ranked as the 10th most frequently mentioned challenge. Approximately 30% of the interviewees noted that creating unrealistic expectations of what SSW could reasonably contribute to communities with respect to waste management (C15) may be a challenge. A participant from the management authority noted that 'a risk or challenge could be that the surrounding community might expect

more than what SSW could contribute to waste management'. As mentioned earlier, Coetzee and Nell (2019) have highlighted that in the South African context, available resources, capacity and expertise of protected areas play an important role in determining the extent to which these areas can realistically contribute to a community development agenda. These authors caution against protected areas creating unrealistic expectations, and they emphasise that protected areas can 'realistically only address some of the identified community needs significantly'.

Lastly, challenges related to community conflicts and competition (C16) for waste management business opportunities were raised. According to Meletis and Campbell (2009), communities in the developing country context generally fail to unite efforts to address waste management issues and that community conflicts remain a concern. Similarly, one of the participants of this research stated that:

'We have twelve different community groups around the reserve. What would their expectations be? Who will benefit and how? The process of community involvement needs to be fair to provide equal opportunities to all; otherwise, it may lead to competition and social conflict.'

There were some concerns raised by participants about competition amongst community members leading to social conflicts and that social unrests may negatively influence the PNR.

Challenges due to the characteristics of the reserve

Some of the challenges brought up by interviewees were related to the characteristics of the reserve. Waste management in protected areas is often complicated because many of these areas are located far from waste-related services and infrastructure, and are therefore likely to have limited waste disposal or treatment options available to them (Meletis & Campbell 2007).

Approximately 67% of research participants highlighted challenges related to code C17 (which was regarded as the second most frequently mentioned challenge):

- *The size of the reserve:* The SSW PNR consists of 49 481 hectares, with commercial and non-commercial properties located in the reserve. The size of the reserve makes it difficult to coordinate waste management measures such as waste collection and makes the establishment of centralised infrastructure for communal use almost impossible.
- *The location of the reserve:* The reserve is located in a rural area, with limited waste management facilities and infrastructure located within a 100 km radius from the reserve.
- *Compatibility of waste options with protected areas expectations:* Incineration was identified as a possible means to divert waste from landfill disposal by some stakeholders. The question was, however, posed regarding the compatibility

of the technology (with potential air quality impacts) in a protected area. Similarly, composting and disposal of waste within the reserve were regarded as challenges because of practical issues such as smells, breeding of vermin and unwanted lure of animals.

Finally, the unavailability of land within the reserve for waste-related activities and infrastructure was raised as a challenge by 37% of interviewees and ranked as the sixth most frequently mentioned code. Participants voiced their reluctance to use valuable conservation land for waste management purposes and added discussions on the complexities of securing privately owned land for communal waste management purposes. The interviewees argued that off-site management of waste would be preferred to on-site waste management.

Opportunities for sustainable solid waste management

Table 2 outlines the perceived opportunities for sustainable solid waste management, as identified by interviewees. According to the four identified themes (A – D in Table 2), key findings are discussed below.

Institutional and legal or policy opportunities

Providing assurance and transparency (O1) was the most frequently mentioned institutional and legal or policy opportunity. Code O1 ranked second overall, with 67% of participants regarding it as an opportunity for sustainable solid waste management. The statements of interviewees indicated that they were concerned about what happens to waste 'beyond the gate', once it leaves the reserve.

Providing assurance and transparency are important aspects of demonstrating legal compliance as far as waste management throughout the entire life cycle (from cradle to grave) is concerned. Providing assurance of sound waste management beyond the gate may include documented information such as waste manifests and waybills, which outline the 'chain of custody' from the point of generation to the final destination of the waste. This information could ultimately be included as part of waste information reporting (code O6) and sustainability reports of lodges.

Providing strategic direction and standardisation (O7) were noted by 43% of respondents, and ranked as the seventh most mentioned opportunity for sustainable solid waste management. This code captured the participants' responses related to the opportunities and benefits of having a common strategic vision with goals for waste management within the reserve across all the properties. Interviewees made reference to the advantages of having 'common goals', 'a shared vision' and 'aligned approaches, policies and plans' towards 'driving coordinated efforts in achieving sustainable solid waste management'. Przydatek (2019) emphasises the advantages of synergised waste management in protected areas, whilst

Sandbrook et al. (2019) highlight the importance of having strategic direction with long-term targets towards waste management. Coordination could also support efficiency, optimisation of resources and economies of scale, with meaningful potential financial benefits over time.

Improving the reputation and brand of the reserve and providing marketing opportunities were mentioned by 40% of the interviewees and ranked as the ninth most frequently mentioned opportunity for sustainable solid waste management. An interviewee from one of the commercial lodges highlighted that:

‘Demonstrating that we are “green” and legally compliant are important for our reputation and it has marketing value. The public sees Sabi Sand Wildtuin as one entity – if one lodge does not perform well, it may impact negatively on the entire reserve. The flip side may also be true; if a couple of us perform well, it impacts positively on the image and brand of the entire reserve.’

The value of environmental management performance towards improving reputation, image and brand is recognised by Reis et al. (2018), who reported that an improvement in image, with associated marketing value, is perceived as one of the most significant benefits of ISO 14001 implementation by organisations. Considering that the commercial properties in SSW target mainly the high-end luxury ecotourism market, reputation and brand value are important.

The 10th most frequently mentioned code (by 33% of interviewees) was O4, where interviewees highlighted the importance of ‘coordinated’, ‘reliable’, ‘efficient’ and ‘effective’ ‘waste services’, which provide for ‘the entire waste management life cycle’ from ‘cradle to grave’ (linking to code O1). Respondents did, however, emphasise that waste management services should be sensitive towards cost. Funding of waste management services was ranked as the third most significant challenge (code C3) for solid waste management in SSW and was mentioned by interviewees representing both commercial and non-commercial properties.

Other institutional and legal or policy opportunities included the following: contributing towards legal compliance (O5); improving monitoring, collection and recording of data and improving communication and reporting (of waste data) (O6); and providing business opportunities within SSW (O7). It seems as if the interviewees regarded business opportunities for waste management as a better prospect for local communities than for the reserve itself (as indicated in code O13); however, nobody could point to a specific proven business case (C6) for community benefits outside the reserve. This remains an area of future research, but at this stage it seems that the amount of waste and the particular waste streams from the reserve provide limited commercial benefits and opportunities. This is important to highlight because unrealistic expectations by communities of the commercialisation potential of reserve waste streams could lead to unintended weakening of relations (as discussed in Section 4.1.3).

Environmental health and ecotourism opportunities

Codes related to environmental health and ecotourism opportunities were not as frequently mentioned as the codes of the other three themes.

Protecting and preserving the environment (O8) ranked sixth, overall, being mentioned by 43% of interviewees. The responses indicated that participants felt that protection and preservation of the environment formed part of their ethical and moral obligations. One participant said that ‘conservation is our core business’ and ‘we have a moral obligation to protect the environment’. Another respondent added that ‘our ethos is “leave the world a better place”’. From a moral point of view, we should all want to engage in responsible waste management’. The contribution of sustainable solid waste management towards protecting and preserving the environment is well-recognised by other authors (Dunjić et al. 2017; Hong & Chan 2010; Rodríguez-Rodríguez 2012; Przydatek 2019).

Meeting visitor expectations (O9) was mentioned by 40% of the participants and ranked as the eighth most frequently mentioned opportunity for sustainable waste management. Du Plessis et al. (2013) and Morrison-Saunders et al. (2019) found that responsible waste management ranked amongst the top expectations of visitors to protected areas in South Africa.

Other health and ecotourism-related opportunities of sustainable solid waste management included addressing visual and aesthetic impacts (O10) related to waste and littering, preventing pollution (O11) and contributing to sustainable environmental management (O12). Birendra (2021) reported that improved waste management has resulted in reduced pollution and positive aesthetic impacts in communities surrounding the Bardia National Park in Nepal, which improved the environmental conditions and enhanced the ecotourism experience of visitors.

Social and cultural opportunities

The most frequently mentioned opportunity related to sustainable solid waste management (ranked as the most significant opportunity overall) was creating jobs and contributing towards livelihoods (O13), which was mentioned by 77% of interviewees. Opportunities raised by participants focused on benefitting and supporting local communities through ‘creating local job opportunities’, ‘creating employment outside tourism activities’, ‘partnering with the private waste sector’ and ‘creating small, medium and micro enterprises (SMMEs)’, with the aim of ‘contributing to livelihoods’ to ultimately ‘improve their quality of life’. This could, in the long run, contribute to community upliftment (O15) and creating cleaner communities (O16).

Meletis and Campbell (2009) highlight the role that the ecotourism sector could play in community support in assisting communities with waste management problems, especially where municipal waste services are limited.

Palfrey, Oldekop and Holmes (2021) highlight the social outcomes of private protected areas, such as local communities benefitting from increased employment, training and community-wide development. Furthermore, the contributions of waste towards the green and circular economies is well-recognised (Márquez & Rutkowski 2020; Taleb & Farooque 2021). In the developing country context, a significant number of jobs have been created from the informal waste sector, where the harvesting of waste contributes to the diversion of waste away from landfilling (Yu, Blaauw & Schenck 2020).

There are, however, several challenges, such as limited justification for a business case (C6), inadequate infrastructure (C9) and services (C10) for waste management and recycling, challenges related to the location of the reserve (C17) and the unavailability of land for the establishment of waste separation and recycling infrastructure within the reserve (C18) (Table 1), which need to be addressed in order for job and livelihoods opportunities to be realised. It is therefore important to reflect on the level of support and job creation that the ecotourism sector, and more specifically protected areas, could reasonably and feasibly contribute to communities. Coetzee and Nell (2019) have cautioned about the risk of creating unrealistic expectations in terms of the level of community support that protected areas could contribute towards sound waste management (also see C15 in Table 1).

The improvement of awareness, knowledge and skills regarding waste management (O14) was also regarded as a significant opportunity related to waste management, which was ranked third and mentioned by 57% of interviewees. Hong and Chan (2010), and Dunjić et al. (2017) highlight the importance of awareness and knowledge of waste, to ultimately improve waste management behaviour in protected areas.

Technical opportunities

Technical opportunities mainly focused on alternatives to landfill disposal of waste. Code O17, focusing on implementing the waste management hierarchy (i.e. avoidance, reduction, separation at source, re-use and recycling), was ranked fourth, with 57% of interviewees mentioning phrases related to this code. Implementing alternatives to landfilling may lead to socio-economic opportunities, as discussed earlier. Although separation of waste at source, re-use, recycling and recovery of waste were highlighted as opportunities, participants also highlighted certain challenges related to implementing the waste management hierarchy (Table 1). In particular, composting (O18) and waste-to-energy (O19) options were mentioned as alternatives to landfilling by a number of participants (Table 2).

Conclusions

This research aimed to identify the challenges and opportunities for sustainable solid waste management in privately protected areas by focusing on SSW, a PNR located in South Africa. 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 foreseen difficulties due to the size and location of the reserve and concerns around funding of waste management measures, especially given the financial implications of COVID-19 travel and tourism restrictions. The most frequently identified opportunities included creating jobs and improving livelihoods, providing assurance and transparency of what happens to waste 'beyond the gate', and improving awareness, knowledge and skills related to waste management.

Private nature reserves should, as far as possible, aim to address the challenges and optimise the opportunities related to waste management by focusing on addressing the following aspects:

- *Must do – achieve legal compliance:* PNRs must align their strategic direction to focus on achieving legal compliance, as a minimum.
- *May do – go beyond legal compliance:* PNRs may support communities and invest in services and infrastructure outside the reserve to enhance waste management opportunities beyond legal compliance.
- *Nice to have – supporting cleaner communities:* It would be beneficial if PNRs support and contribute to cleaner communities with less environmental pollution and reduced aesthetic impacts, which will have direct benefits for communities and secondary improved aesthetic impacts for the PNR, which would ultimately lead to improved conservation efforts.

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Competing interests

The authors declare that they have no financial or personal relationships that may have inappropriately influenced them in writing this article.

Authors' contributions

C.R., R.C.A. and F.P.R. conceptualised the project and were responsible for the data collection, analysis and interpretation. W.H. played an important role in scheduling interviews and accompanying the research team during data collection. All authors played a role in drafting and critically revising the manuscript for important intellectual content and approved the final version to be published.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article (Tables 1 and 2).

Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.

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