Charting a New Sustainability Course for Luxury Game Lodges in Africa: A Hybrid Analytical Framework for Analysing the Key Coupled Human and Natural System Components

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Abstract

This paper introduces a hybrid analytical framework to comprehensively assess luxury game lodges within protected areas such as Coupled Human and Natural Systems (CHANS). The framework, developed through a synthesis of diverse Social-Ecological Systems (SES) models and tools, encompasses eight key steps, from sustainability context assessment to creating a tailored managerial-ecology model. By systematically analysing ecological, social, and economic dimensions, this framework empowers stakeholders to make informed decisions that balance biodiversity conservation, sustainability, and community engagement in luxury game lodge operations. Its practical application promises to advance the coexistence of ecotourism and environmental protection, fostering the long-term viability of these vital tourism destinations within protected areas.

Keywords: Ecotourism; luxury game lodges; protected areas; analytical framework; sustainability

Introduction

Tourism, often seen as a driver of social and economic growth, holds the potential to exert a profound influence on ecosystem processes and structures within protected areas. While facilitating progress, this influence can also strain non-renewable natural resources

(Lacitignola et al., 2007; Salama & Mansour, 2022). With tourist numbers on an exponential rise, especially in remote regions, a spotlight has been cast on the paradoxical nature of nature-based tourism (Hillery et al., 2001; Lynn & Brown, 2003; Wolf et al., 2019). Moreover, debates have ensued regarding the effectiveness of sustainability measures and initiatives in place (Assefa, 2022; Lacitignola et al., 2007). The impact of tourism on a destination is a complex interplay involving host communities, tourists, and the landscapes they visit (Farrell & Twining-Ward, 2004; Lacitignola et al., 2007; McMinn & Cater, 1998; Mutanga et al., 2021; Wolf et al., 2019). While tourism can offer significant socio-economic benefits, contributing to economic opportunities and improved quality of life for both visitors and local communities (Goodwin, 2011; Heslinga et al., 2017; McCombes et al., 2015; McCool & Spenceley, 2014), focusing solely on these aspects may prove ecologically undesirable. Natural resources such as water, biodiversity, and ecosystem services are already under strain due to tourism's resource utilisation (Heslinga et al., 2017). Thus, the challenge lies in balancing socio-economic development and protecting the environment (Heslinga et al., 2017).

To address this challenge, the researchers adopt a social-ecological systems (SES) perspective, recognising the interdependence of nature and society (Cumming, 2011). Viewing landscapes and tourism as integral components of an interconnected and dynamic system rather than as isolated entities is a promising approach (Farrell & Twining-Ward, 2004; Heslinga et al., 2017; Kirchhoff et al., 2010; Levin et al., 2012). However, research that delves into the interactions between landscapes as natural environments and ecotourism is currently lacking (Gkoltsiou & Terkenli, 2012; Heslinga et al., 2017). This article addresses this research gap by unravelling the intricate dynamics between the natural environment and ecotourism, particularly in the context of luxury game lodge destinations in Africa. These destinations epitomise the complexities and opportunities inherent in sustainable ecotourism. By analysing the destinations through the lens of coupled SES, the researchers aimed to chart a new path toward harmonising development with conservation in protected areas.

The primary objective of this article is to decipher the interactions between the natural environment and ecotourism as dynamic and complex social-ecological couplings. Specifically, the researchers investigated the human and natural systems and subsystems constituting SES and the couplings that bind them, creating an intricate and interconnected nexus. The central contribution of this work lies in developing and applying a hybrid analytical framework for luxury game lodge destinations in Africa. This framework integrates established social-ecological concepts with novel analytical approaches, providing a comprehensive tool for assessing and enhancing the sustainability of these unique destinations. Through this innovative framework, the researchers aim to offer insights and practical guidance for policymakers, researchers, and practitioners in the field of ecotourism and protected area management.

Sustainable development assessment in ecotourism: The argumentative discourse in social-ecological systems

The pursuit of sustainable development in ecotourism within protected areas aims to balance economic progress, ecological conservation, and social well-being, with ecotourism contributing to mitigating negative social and environmental impacts while enhancing local economic viability, health, education, and infrastructure (Falatoonitoosi et al., 2021; Medina-Muńoz et al., 2016; Swarbrooke, 1999; Yu et al., 2011). Sustainable tourism development, recognised as a means for poverty alleviation, gained global prominence through initiatives like the United Nations Rio+20 summit, highlighting its role in improving human well-being, addressing environmental and poverty-related Millennium Development Goals, and aligning

with Agenda 2030's sustainable development goals (Griggs et al., 2013; Falatoonitoosi et al., 2021).

However, the concept of sustainable ecotourism remains contentious, lacking a universally accepted definition and suffering from diverse interpretations rooted in various disciplinary traditions, complicating its application (Balas & Abson, 2022; Zhang et al., 2022). Despite its positive intentions, ecotourism presents environmental challenges such as soil degradation, biodiversity loss, stakeholder conflicts, and contributions to global warming and pollution (Aslan et al., 2021; Azam et al., 2018; Guzel & Okumus, 2020; Monz et al., 2013; Snyman, 2012; Syam et al., 2019; Zhong et al., 2020). In contrast, ecotourism, distinct from mass tourism, prioritises low-impact practices, cultural and biodiversity sensitivity, resource conservation, equitable benefit distribution, community involvement, and environmental education, playing a vital role in biodiversity conservation and community well-being (Buckley, 2020; Confente & Scarpi, 2021; Ding & Cao, 2019; Harris et al., 2021; Liang et al., 2018; Yergeau, 2020; Zhang et al., 2020).

In addition, realising sustainable management in ecotourism faces barriers, including prioritising profit over environmental measures by management and a lack of adequate tools for communicating sustainable options among stakeholders (Martinez-Fernandez et al., 2020; Stabler & Goodal, 1997). Robust empirical impact assessments are needed to evaluate sustainability's effects on destination prosperity (Falatoonitoosi et al., 2021). In acknowledging the argumentative discourse within SES, a need is identified that requires the alignment of sustainability principles with the complexities of luxury game lodge destinations in African protected areas, therefore proposing a hybrid analytical framework for sustainable development (Falatoonitoosi et al., 2021) toward planetary health (Schoeman et al. 2023).

SES are intricate networks merging ecosystems and human communities into dynamic wholes (Berkes & Folke, 1998; Bodin & Tengö, 2012; Folke et al., 2016; Schlüter et al., 2019). SES exhibit self-organisation, revealing complex relationships and emergent properties with abrupt systemic changes at tipping points (Holling, 2001; Urry, 2005). These systems generate structures, patterns, and dynamics through interactions marked by unpredictability and uncertainty due to numerous variables (Levin et al., 2012; Schlüter et al., 2019). Emergence in SES involves novel properties beyond constituent elements, shaping future actions and ecosystem dynamics (Moore et al., 2018; Page, 2015; Schlüter et al., 2019). SES offers a crucial framework for addressing global issues, such as the COVID-19 pandemic, through interdisciplinary solutions (Bonilla-Moheno et al., 2021; Kadykalo et al., 2022), emphasising feedback loops, nonlinear dynamics, and shared language across disciplines (Hertz & Schlüter, 2015; Liu et al., 2007a,b). It recognises complex social and natural entanglements, resilience building, and inclusive participation, underpinning the capacity to endure perturbations and foster sustainability (Folke, 2006; Kadykalo, 2022 Schneider et al., 2021). SES aids in comprehending the intricate interplay between natural and human systems and guides holistic assessments for addressing challenges like ecotourism in protected areas (Schlüter et al., 2019).

Methodology
The methodology in developing a hybrid analytical framework for analysing the key CHANS components comprised two main critical literature review parts, namely thedeveloping an SES framework for luxury game lodge destinations in protected areas, and

(a) identifying the key human and natural systems and subsystems as SES Second-Tier variables.

Developing an SES framework for luxury game lodge destinations in protected areas
Integrating SES concepts into biodiversity conservation, particularly in protected areas and ecotourism, is gaining increasing recognition (Preiser et al., 2018). The core principle of SES

science is the recognition that human and natural systems are deeply interlinked (Berkes et al., 2003; Diaz et al., 2006; Summers et al., 2012; Wu, 2013), with causality operating in both directions, leading to complex, intertwined dynamics (Fischer-Kowalski & Weisz, 2016; Quintas-Soriano et al., 2022). SES frameworks incorporate complex adaptive systems concepts such as critical thresholds, tipping points, regime shifts, cross-scale linkages, feedback loops, and nonlinearities to explain the intricate nature of SES behavior (Carpenter, 2003; Folke et al., 2011; Hughes et al., 2013; Scheffer et al., 2012; Walker et al., 2006;). These concepts are essential for understanding the dynamics and features of SES (Preiser et al., 2018) in protected areas.

The SES framework, initially developed by Elinor Ostrom (2007, 2009) and later updated by McGinnis and Ostrom (2014), serves as a common language for scholars from diverse disciplines to share their work on sustainable resource management (Baudoin & Arenas, 2020). It provides an analytical tool to convey the complex causality of relationships within a system, especially where feedback loops are expected (Boons, 2013). The SES framework is considered the most balanced and universal, encompassing social and ecological aspects (Baudoin & Arenas, 2020; Binder et al., 2013). It accommodates findings and themes in a theory-neutral context (Ostrom, 2009). The SES framework (Figure 1) consists of various top-tier or first-tier components, including Resource Systems (RS), Resource Units (RU), Governance Systems (GS), and Actors (A), with Action Situations as Interactions (I) and Outcomes (O) being the focal points of activity (McGinnis and Ostrom, 2014). Feedback loops operate from action situations to the top-tier variables. The SES framework recognises that exogenous influences from related ecological systems or socio-economic settings can affect any component of the SES (McGinnis & Ostrom, 2014). Feedback paths within the framework demonstrate an explicitly dynamic structure, linking action outcomes to contextual variables (McGinnis & Ostrom, 2014). All top-tier categories, including RS, RU, A, and GS, are inputs and outputs for one or more action situations, contributing to the framework's dynamism (McGinnis & Ostrom, 2014).
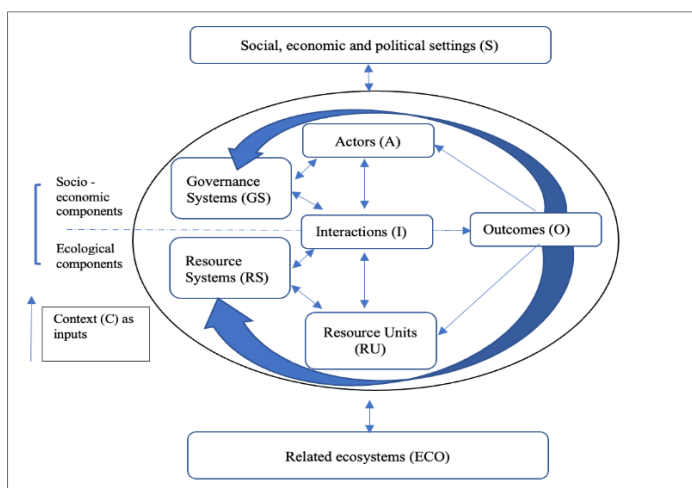

Figure 1. The components of the social-ecological framework (as adopted from Baudoin & Arenas, 2020, Ferreira et al., 2018, McGinnis & Ostrom, 2014 and Ostrom, 2009)

To apply the SES framework to ecotourism in protected areas, a three-step process has been followed (McGinnis & Ostrom, 2014; Palomo & Hernandez-Flores, 2019), Firstly,
Identifying Economic Categories: Four main economic categories, derived from using natural resources in protected areas for ecotourism (e.g., lodge operations, infrastructure and its impacts, conservation and wildlife, governance, and community), and were selected based on

relevant literature. Each category corresponds to specific Resource Units (RU), users (Actors), governance rules, interactions, and outcomes, allowing for the separation of activities into subsystems within the SES. Secondly, Selecting Second-Tier Variables: Relevant second-tier variables that reflect the unique characteristics of each of the four subsystems were chosen for deciphering and lastlycreating a Clear SES Framework: A well-defined SES framework was established for comparing research results and facilitating information exchange among case studies.

Identifying the key human and natural systems and subsystems as SES second-tier variables
According to Ostrom and McGinnis (2014), in Table 1 and Supplementary Table 1, the four SES subsystems are described with first and second-tier variables.

Table 1: First and second-tier variables as applied to the four Social-Ecological subsystems of ecotourism destinations in protected areas

First Tier Variable	Second Tier Variable
Social, economic, and political settings (S)	S1 – Economic development
	S2- Demographic trends
	S3 – Political stability
	S4 – Other governance systems
	S5 – Markets
	S6 – Media Organisations
	S7 – Technology
Resource Systems (R.S.)	RS1 – Sector
	RS2 – Clarity of system boundaries
	RS3 – Size of resource system
	RS4 – Human-constructed facilities
	RS5 – Productivity of system
	RS6 – Equilibrium properties
	RS7 – Predictability of system dynamics
	RS8 – Storage characteristics
	RS9 – Location
Governance Systems (G.S.)	GS1 – Policy area
	GS2 – Geographic scale of governance system
	GS3 – Population
	GS4 – Regime type
	GS5 – Rule-making organisations
	GS6 – Rules in use
	GS7 – Property rights systems
	GS8 – Repertoire of norms and strategies
	GS9 – Network structure
	GS10 – Historical continuity
Resource Units (R.U.)	RU1 – Resource unit mobility
	RU2 – Growth and replacement rate
	RU3 – Interaction among resource units
	RU4 – Economic value
	RU5 – Number of units
	RU6 – Distinctive characteristics
	RU7 – Spatial and temporal distribution
Actors (A)	A1 – Number of relevant actors
	A2 – Socio-economic attributes
	A3 – History or past experiences
	A4 – Location
	A5 – Leadership/entrepreneurship
	A6 – Norms (trust-reciprocity)/social capital
	A7 – Knowledge of SES/mental models
	A8 – Importance of resource (dependence)
	A9 – Technologies available
Action situations: Interactions (I) – Outcomes (O)	I1 – Harvesting
	I2 – Information sharing
	I3 - Deliberation processes
	I4 - Conflicts
	I5 - Investment activities
	I6 – Lobbying activities
	I7- Self-organising activities
	I8 – Networking activities
	I9 – Monitoring activities
	I10 – Evaluative activities
	O1 – Social performance measures
	O2 – Ecological performance measures
	O3 – Externalities to other SESs
Related Ecosystem (RE)	ECO1 – Climate patterns
	ECO2 – Pollution patterns
	ECO3 – Flows into and out of focal SES

Adapted from Ostrom and McGinnis (2014)

The order in which they are described:
    a) The SES of game lodge operations in protected areas;

b) The SES of game lodge infrastructure in protected areas;
c) The SES of conservation and wildlife; and
d) The SES of governance, sustainability and community.

In analysing the SES of game lodge operations in protected areas, it's crucial to consider various second-tier variables within different categories. In the social, economic, and political settings (S), economic development influences game lodges' financial resources and viability, while demographic trends and political stability impact planning and collaboration. Governance systems (GS) encompass policy areas, governance scale, and historical continuity, crucial for effective governance and community engagement. Resource systems (RS) include variables like sector and system boundaries, essential for managing resource systems within game lodges. Resource unit (RU) variables like mobility and economic value are vital for sustainable resource management. Actors (A) variables, such as leadership and social capital, shape interactions and outcomes. Action situations (I) and outcomes (O) variables cover various aspects of game lodge operations, from harvesting to externalities, guiding management practices. Finally, related ecosystem (RE) variables like climate and pollution patterns and flows into and out of the SES help game lodges understand and minimise their ecological impact. These considerations enable sustainable management, conservation, and community engagement in game lodge operations within protected areas (Borrie & Bigart, 2021; Bothma & Du Toit, 2016; Bristow & Bell, 2013; Eagles et al., 2021; Erkkonen & Kajala, 2021; Mandic 2021; Massyn 2021; Kariithi 2021; Legrand et al., 2023; Saayman, 2009; Saayman et al., 2013; Slabbert & Saayman, 2003; Snyman & Spenceley, 2019; Spenceley 2021; Twining-Ward et al., 2021; Van der Merwe & Du Plessis, 2014; Van der Merwe & Saayman, 2004).

In analysing the SES of luxury game lodge infrastructure in protected areas, various second-tier variables across different categories come into play. In the social, economic, and political settings (S), economic development, demographic trends, political stability, governance systems, markets, media organisations, and technology influence the sustainability, governance, and community engagement aspects of ecotourism infrastructure. Resource Systems (RS) variables such as the nature of the sector, system boundaries, and size of the resource system are essential for understanding and managing the resource systems associated with game lodge infrastructure. Governance Systems (GS) variables, including policy area, governance scale, and historical continuity, are crucial for effective governance and community engagement in game lodge infrastructure development. In the Resource Units (RU) category, variables like resource unit mobility, growth and replacement rate, and economic value are pivotal in understanding and managing the SES related to game lodge infrastructure. Actors (A) variables such as leadership, norms, knowledge of SES, and technologies available provide valuable insights into the interactions between human and natural systems and influence decision-making processes related to infrastructure development. The Action situations: Interactions (I) and Outcomes (O) variables cover various aspects of game lodge infrastructure, from harvesting and conflicts to monitoring and ecological performance measures, helping assess the complexity of interactions and outcomes. In the Related Ecosystem (RE) category, variables like climate patterns, pollution patterns, and flows into and out of the focal SES are crucial for understanding and mitigating the ecological impact of game lodge infrastructure on the surrounding environment. These considerations enable sustainable development, responsible governance, and ecological conservation in game lodge infrastructure within protected areas, contributing to the overall sustainability and biodiversity preservation goals (Borrie & Bigart, 2021; Bothma & Du Toit, 2016; Bristow & Bell, 2013; Eagles et al., 2021; Erkkonen & Kajala, 2021; Mandic 2021; Massyn 2021; Kariithi 2021; Legrand et al., 2023; Saayman, 2009; Saayman et al., 2013; Slabbert & Saayman, 2003; Snyman & Spenceley, 2019;

Spenceley 2021; Twining-Ward et al., 2021; Van der Merwe & Du Plessis, 2014; Van der Merwe & Saayman, 2004).

In the SES of conservation and wildlife in protected areas, focusing on ecotourism, second-tier variables within various categories are crucial for understanding and managing the system effectively. In the social, economic, and political settings (S), economic development, demographic trends, political stability, governance systems, markets, media organisations, and technology all impact conservation efforts, including ecotourism, ensuring sustainability and community engagement. In Resource Systems (RS), variables like sector, system boundaries, size, and human-constructed facilities are essential for resource management in protected areas. Governance Systems (GS) variables such as policy area, population, and historical continuity influence governance and conservation success. Resource Unit (RU) variables like mobility, growth rate, and distinctive characteristics inform wildlife management strategies. Actors (A) variables, including leadership, social capital, and technologies available, provide insights into stakeholder dynamics and conservation approaches. Action situations (I) and Outcomes (O) variables, like harvesting, conflicts, and ecological performance measures, are pivotal for assessing and promoting sustainable practices. In the Related Ecosystem (RE) category, climate patterns, pollution patterns, and flows into and out of the focal SES are critical considerations, ensuring ecological integrity and resilience. By incorporating these second-tier variables, conservation and ecotourism efforts can be better informed, fostering long-term biodiversity preservation and sustainable economic activities in protected areas (Borrie & Bigart, 2021; Bothma & Du Toit, 2016; Bristow & Bell, 2013; Eagles et al., 2021; Erkkonen & Kajala, 2021; Mandic 2021; Massyn 2021; Kariithi 2021; Legrand et al., 2023; Saayman, 2009; Saayman et al., 2013; Slabbert & Saayman, 2003; Snyman & Spenceley, 2019; Spenceley 2021; Twining-Ward et al., 2021; Van der Merwe & Du Plessis, 2014; Van der Merwe & Saayman, 2004).

In governance, sustainability, and community engagement in protected areas, with a focus on ecotourism, second-tier variables within the SES framework are crucial. Economic development (S) influences financial resources, demographic trends shape needs and preferences, and political stability fosters effective governance. Governance systems (GS) encompass policy areas, population dynamics, and historical continuity, all critical for managing sustainability and community engagement. Resource systems (RS) involve system boundaries, resource productivity, and infrastructure, influencing sustainable practices. Actors (A), including leadership and knowledge, impact decision-making and community involvement. Action situation variables (I and O), such as conflict resolution and investment activities, play a vital role in achieving sustainability goals. The Related Ecosystem (RE) variables, such as climate and pollution patterns and flows into and out of the system, are essential for managing ecological integrity and community well-being. By considering these second-tier variables, stakeholders can develop effective governance, promote sustainability, and engage communities while fostering ecotourism as a sustainable practice in protected areas (Borrie & Bigart, 2021; Bothma & Du Toit, 2016; Bristow & Bell, 2013; Eagles et al., 2021; Erkkonen & Kajala, 2021; Mandic 2021; Massyn 2021; Kariithi 2021; Legrand et al., 2023; Saayman, 2009; Saayman et al., 2013; Slabbert & Saayman, 2003; Snyman & Spenceley, 2019; Spenceley 2021; Twining-Ward et al., 2021; Van der Merwe & Du Plessis, 2014; Van der Merwe & Saayman, 2004).

The proposed hybrid analytical framework for analysing CHANS components
In ecotourism, researchers and practitioners tackle the intricate dynamics of coupled SES. These systems involve the interplay between human societies and the natural environment. To unravel and manage these complexities, various models and frameworks have been devised

(Table 2). These tools integrate ecological, social, and economic aspects, aiming to provide structured insights and strategies for sustainable management. Notable SES frameworks in ecotourism include Ostrom's SES Framework, the Social-Ecological Inventory (SEI), the Resilience Assessment Framework (RAF), Adaptive Co-Management (ACM), Driver-force-Pressure-State-Impact-Response (DPSIR), and causal loop diagrams, among others. Each of these tools has merits and limitations. Yet, they collectively strive to grasp the intricate dynamics of coupled SES and devise management strategies that balance ecological, social, and economic goals.

Table 2: A comprehensive summary of the identified conceptual framework components.

Framework Component	Type	Purpose	Application	Examples
Ostrom's SES framework	Framework	Analyse social-ecological systems and guide governance	Natural resource management, environmental governance, policy design, institutional analysis	Lobster fishing and ecotourism in Mexico (Palomo & Hernáandez-Flores, 2019), tourism systems in Nepal (Nyaupane et al., 2018), biosphere reserve management (Ferreira et al., 2018), SES of a protected area in the Yucatan Peninsula (Bonilla-Moheno et al., 2021)
DPSIR framework	Framework	Analyse environmental problems and solutions	Environmental assessments, climate change, resource management, biodiversity conservation, water management	Sustainable tourism (Mandic 2020), global wildfire-water risks (Robinne et al., 2018), tourism ecological security in China (Ruan et al., 2019), ecotourism in a Mangrove area in Thailand (Swangjang & Kornpiphat, 2021)
Causal Loop Diagramming	Diagram Tool	Understand system relationships and feedback loops	System thinking, identifying causes/effects, problem-solving	Nature-based solutions in Romania (Coletta et al., 2021), ecosystem services in Portugal (Lopes & Videira, 2017), sustainable ecotourism development plans (Husain et al., 2021)
Resilience Assessment	Framework	Evaluate system resilience to stressors and shocks	Disaster management, community development, business continuity, landscape planning, climate adaptation	Vulnerability and resilience of tourism destinations (Calgaro et al., 2014), nature-based solutions (Beceiro et al., 2020), resilience analysis of engineered and infrastructure systems (Francis & Bekera, 2014)
Social-Ecological Inventory	Framework	Assess human-environment relationships	Environmental management, community development, conservation planning, disaster management	Ikel Watershed in Moldova (Ciobanu & Saysel 2021), ecosystem management (Schultz et al., 2007), climate change adaptation in Bangladesh (Bahauddin et al., 2016)
Social Network Analysis	Tool	Analyse social network relationships	Organisations, communities, ecosystems, social interactions	Biodiversity conservation in Romania and Ukraine (Gogaladze et al., 2020), sustainable management of wetlands in Rwanda (Sylvere and Emmanuel, 2016), improving environmental interventions (De Lange et al., 2019)
Nexus	Framework	Enhance resilience in socio-ecological systems	Analyse interconnections, resource flows, trade-offs, integrated resource management	Water metabolism (Gain et al., 2021), nature-based tourism (Blanco, 2011), Water-Energy-Food nexus in Everest Tourist Region, Nepal (Aubriot et al., 2019)
Telecoupling	Framework	Assess the impacts of interactions on SES	Evaluate drivers, feedback loops, spillover effects, cross-boundary interactions	Ecosystem services (Martin-Lopez et al., 2019), eco-certification (Da Silva et al., 2019), global sustainability (Liu et al., 2018)
Adaptive Co-Management	Framework	Collaborative resource management	Natural resource management, biodiversity conservation, sustainable development	Climate change adaptation governance in Bangladesh (Bahauddin et al., 2016), marine SES (Gray & Scyphers, 2017)
Vulnerability Assessment	Framework	Evaluate system vulnerabilities and risks	Climate change adaptation, community engagement, disaster management, resource management	Coastal deltas vulnerability (Sebesvari et al., 2016), tourism to natural disasters (Matusin et al., 2019), vulnerability assessment for Atoll Islands (SPC, 2016)
SWOT Analysis	Framework	Understand system strengths, weaknesses, opportunities, and threats	Informed decision-making, strategies, sustainability	Ecotourism as sustainable tourism (Swangjang and Kornpiphat, 2021), tourism development planning in the Philippines (Rebuya and Gasga, 2022), ecotourism sustainable development strategies in Iran (Ghorbani et al., 2015)
Stakeholder Analysis	Framework	Understand and engage diverse stakeholders	Inclusive decision-making, collaborative networks, conflict management, equitable solutions	Sustainable tourism development in Piatra Craiului National Park (Candrea and Bouriaud, 2009), community-based ecotourism development in Indonesia (Yuliani et al., 2019)

This study extensively explored various conceptual framework components related to SES, including models, frameworks, and tools, to identify resources specifically applicable to ecotourism within protected areas. These insights created an analytical framework for assessing luxury game lodges as coupled social-ecological systems. The review encompassed academic papers, research studies, existing models, frameworks, and practical tools in the social-ecological systems domain, rigorously analysed and evaluated for relevance within ecotourism and protected areas. The culmination of this review is summarised in Table 2.

Leveraging these insights, the objective was to develop a tailored hybrid analytical framework for assessing luxury game lodges as coupled SES. This framework will provide a systematic and comprehensive approach to understanding interactions between human and natural systems, particularly within luxury game lodges, thereby advancing their sustainable

development and management within protected areas. Ultimately, it will contribute to creating a managerial ecology model specific to luxury game lodges in protected areas.

The hybrid analytical framework, as illustrated in Figure 2, synthesises various SES frameworks, encompassing DPSIR, Causal Loop Diagramming, nexus, adaptive co-management, social-ecological inventory, social network analysis, vulnerability assessment, SWOT analysis, stakeholder analysis, resilience assessment, and telecoupling. This comprehensive approach enables a systematic analysis of the critical components characterising luxury game lodge destinations as coupled social-ecological systems. The framework has eight key steps, as indicated in Table 3.
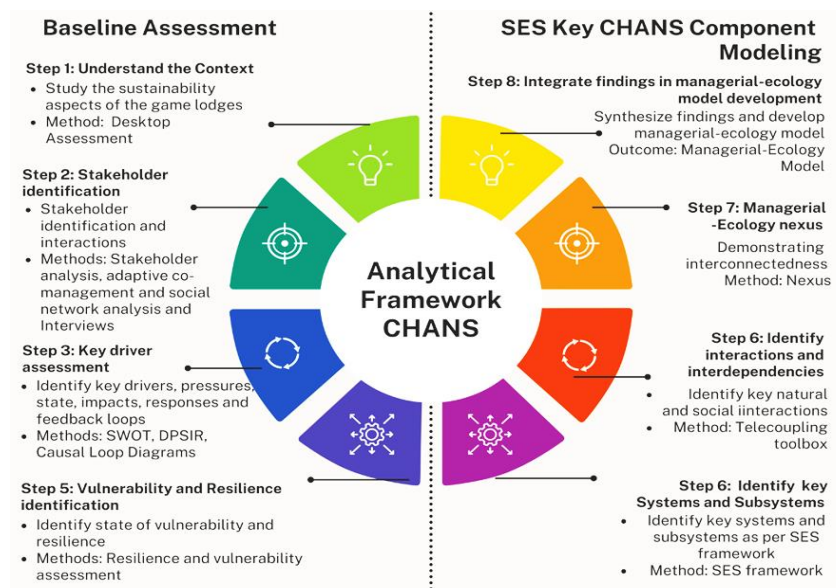

Figure 2: The hybrid analytical framework for analysing the key Coupled Human and Natural System (CHANS) components

Table 3: The eight steps of the hybrid analytical framework for analysing the key Coupled Human and Natural System (CHANS) components

Step	Description
1	Sustainability Context Assessment: Thoroughly examine sustainability aspects of luxury game lodges, including ecological, social, and economic dimensions, to gather vital information.
2	Stakeholder Analysis and Interactions: Identify and analyse diverse stakeholders, interests, power dynamics, and collaborative relationships within luxury game lodges.
3	Key Drivers and Feedback Loop Assessment: Assess primary drivers and feedback loops using tools like SWOT analysis and causal loop diagrams to understand ecological and socio-economic influences.
4	Vulnerability and Resilience Evaluation: Evaluate the system's vulnerability and resilience concerning socio-economic and environmental stressors to gauge adaptability and recovery potential.
5	Identification of Key Systems and Subsystems: Identify and analyse critical systems and subsystems within luxury game lodges using the SES framework to understand their interactions and dynamics.
6	Analysis of Interactions and Interdependencies: Analyse interactions among natural and social components using telecoupling analysis and social-ecological inventory methods.
7	Managerial-Ecology Nexus Exploration: Explore the interdependence between management practices and ecological processes, uncovering implications on sustainability and conservation efforts.
8	Integration of Findings into Managerial-Ecology Model Development: Synthesise findings into a comprehensive model customised for luxury game lodges, aiding decision-makers in sustainable operations.

By integrating the diverse findings from the earlier steps, a robust managerial ecology model can be developed to capture the complexity of luxury game lodge destinations. This model encompasses the essential relationships, feedback loops, and management interventions necessary for promoting sustainable operations and conservation outcomes. As a powerful decision-support tool, it enables stakeholders to make informed choices by illuminating the interconnectedness between managerial practices and ecological dynamics. The comprehensive managerial-ecology model derived from this framework equips decision-makers with the knowledge and understanding to effectively balance environmental conservation and socio-economic considerations.

Applying the proposed hybrid analytical framework for analysing CHANS components
The proposed hybrid analytical framework was implemented in a study involving 20 luxury game lodges that voluntarily participated in South Africa, spanning the public and private sectors, including public-private partnerships. Data collection for this study predominantly employed qualitative methods. These methods were chosen to provide in-depth insights into the experiences and practices of the luxury game lodge management teams concerning conservation, management, and maintenance for the purpose of achieving sustainable development (Du Plooy-Cilliers & Cronje, 2014; Strydom & Bezuidenhout, 2014).Two specific qualitative data collection methods were employed in this study: interviews (as a form of action research) and observations (as observational research). Using these methods allowed for a comprehensive exploration of the subject matter, enabling a deeper understanding of the complexities surrounding the management of luxury game lodges in protected areas.

Atlas.ti 23 was selected as the primary analytical tool to analyse the interview responses obtained from the research participants. The utilisation of ATLAS.ti 23 played a crucial role in systematically coding and analysing the qualitative data. This approach provided a structured and rigorous framework for examining the data, leading to extracting meaningful insights and identifying patterns and trends within the dataset. This systematic analysis was fundamental in achieving the study's objectives and drawing informed conclusions from the qualitative data.

Results and discussion
The application of the proposed framework involved a comprehensive assessment of 20 luxury game lodges situated across the Northern Cape, Mpumalanga, North-West, and KwaZulu-Natal Provinces in South Africa. This assessment encompassed various key aspects, including understanding the contextual landscape, stakeholder identification, key driver assessment, vulnerability and resilience identification, identification of key systems and subsystems, analysis of interactions and dependencies, evaluation of the managerial ecology nexus, and the subsequent integration of findings to develop a managerial-ecology model. A visual representation of this process as key insights in applying the framework is presented in Figure 3.

In addition, valuable insights were obtained while applying the framework. Regarding conservation and sustainability, respondents emphasised the critical importance of continued efforts in conserving rhinos within the region, primarily due to their critically endangered status. Recommendations included practices such as dehorning rhinos, the implementation of robust anti-poaching measures, and the prompt reporting of any unusual sightings or activities within the reserve. Moreover, it was stressed that the lodges should adhere to existing boundaries and infrastructure to minimise any adverse environmental impacts. Advocating for community support initiatives, including employment opportunities and income generation, was considered essential to dissuade unsustainable practices. Education and awareness were noted as pivotal, but it was recognised that insufficient job opportunities could lead to desperate measures. Hence, there were suggestions to support community farming projects and prioritise local sourcing of produce. The respondents acknowledged their challenges, including financial sustainability, dependence on tourism, managing community expectations, adhering to regulations, and minimising ecological impacts. Communication, collaboration, and establishing solid relationships with the local community were underlined as crucial aspects of their sustainability efforts.

Maintenance representatives discussed various challenges encountered in maintaining vehicles and the significance of preserving the lodge's roads and infrastructure. Water availability and supply emerged as significant concerns, with sustainability initiatives like separating grey and black water and utilising solar geysers being proposed. However, financial

constraints were identified as a hindrance to implementing such initiatives. Difficulties pertaining to acquiring funding and approvals for new technologies and sustainability projects were also acknowledged. The respondents expressed a keen interest in making more sustainable changes, such as adopting inverter products and employing gas stoves. Challenges associated with load shedding and the high costs of operating generators were also discussed. The respondents demonstrated a commitment to minimising negative environmental impacts and explored challenges in implementing solar projects and the procedures involved in securing funding for sustainability projects. Additionally, they delved into challenges related to waste management and the search for reliable recycling options. The interactions between wildlife and infrastructure, as well as issues concerning human-wildlife conflict, were addressed. The respondents also discussed challenges tied to infrastructure maintenance and their approach to sustainability, including the challenges posed by electrical issues, animal interactions, and implementing sustainability initiatives. They expressed their desire to transition to solar power and identify practical water and electricity usage solutions while also showing interest in learning from sustainability initiatives implemented at other destinations.

Respondents from luxury lodge management aimed to promote sustainability-related practices and had already implemented various initiatives, such as the adoption of solar power and efforts to reduce plastic waste. They actively engaged with the local community and prioritised local procurement. Recognising the importance of staff education, some had already established partnerships with local schools. Challenges associated with implementing sustainability initiatives were acknowledged, with some lodges striving to be industry leaders and emphasising water and environmental conservation. The significance of communication and discipline within the park was highlighted, and the lodge management expressed their openness to further guidance. Additional respondents pointed out challenges related to human-wildlife interactions and the need for stricter sustainability regulations. These management teams prioritised local sourcing of materials, with the financial feasibility being dependent on market focus. The value of trust and caution in addressing sustainability issues was also underscored.

This insightful analysis and engagement of stakeholders within the luxury game lodges underscore the multifaceted approach to conservation, sustainability, and management, reflecting the intricate dynamics of these unique destinations.
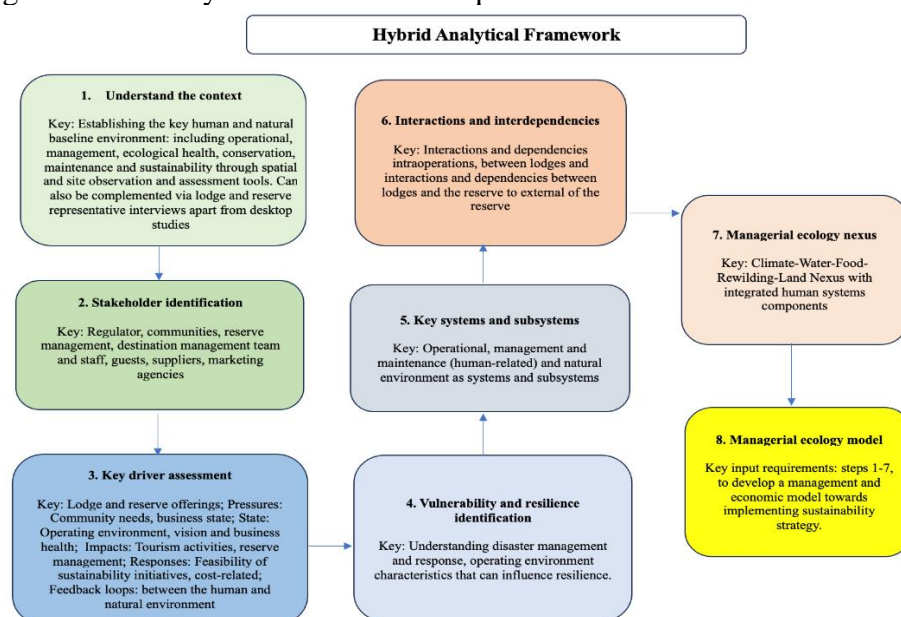

Figure 3: Key insights from applying the hybrid analytical framework applied in 20 luxury lodges in South Africa

Operationalising the framework

The proposed hybrid analytical framework, tailored for luxury game lodges within protected areas, is a versatile tool that can be operationalised to drive sustainability in various settings, extending beyond luxury lodges. It offers a structured approach to understanding the interplay between human societies and the natural environment. Here, the researchers delve into the operational aspects of the framework and explore its potential applicability to non-luxury lodges:

(a) While the framework was originally designed with luxury game lodges in mind, it's flexible and can be customised to suit the specific context and needs of different types of lodges. Non-luxury lodges, which may have varying goals and resources, can adapt the framework by emphasising aspects most relevant to their operation.

(b) One of the framework's strengths is its capacity to engage diverse stakeholders. Community involvement and collaboration with local authorities are also essential components for non-luxury lodges. Adapting the Stakeholder Analysis and Interaction step can help build strong partnerships, which is crucial for lodges promoting community well-being.

(c) Sustainability and environmental protection should be a concern for all types of lodges. Non-luxury lodges can apply the framework to assess their environmental footprint, identify areas where they can reduce their impact, and contribute to local conservation efforts.

(d) While luxury lodges may have more substantial financial resources, non-luxury lodges often operate under tighter budgets. The framework can be used to allocate resources efficiently, prioritise initiatives that will yield the most substantial socio-economic and ecological benefits, and seek out funding opportunities for sustainable projects.

(e) The framework can facilitate the scaling process as non-luxury lodges seek to expand or replicate their model. It helps in maintaining consistency in sustainability practices across multiple sites.

(f) Non-luxury lodges can draw valuable lessons from the sustainability practices of their luxury counterparts. While resource disparities exist, luxury lodges often pioneer innovative sustainability initiatives. Non-luxury lodges can adapt and apply these ideas on a smaller scale.

The proposed hybrid analytical framework provides a roadmap for integrating sustainability into lodge management. It is versatile and can be tailored to various contexts, including non-luxury lodges. By employing this framework, all lodges, regardless of their luxury status, can take substantial steps towards harmonising human interests with preserving our natural world. They can contribute to ecotourism and global conservation efforts while offering unforgettable experiences to visitors and local communities. As the framework becomes more widely adopted, the collective impact on our planet's precious biodiversity and the sustainable enjoyment of its ecosystems will undoubtedly be substantial.

It is also important to note the distinguishing features of the hybrid analytical framework. The proposed hybrid analytical framework for assessing luxury game lodges within protected areas differs from conventional sustainability approaches in several key ways:

(a) Conventional sustainability approaches often focus on a single aspect of sustainability, such as environmental conservation or economic development. In contrast, the hybrid framework adopts a holistic view, considering the interdependencies between human and natural systems. It recognises that sustainability is a complex interplay of ecological, social, and economic factors.

(b) While conventional approaches may address environmental and social aspects separately, the hybrid framework significantly emphasises the concept of CHANS. It highlights the interconnectedness of human societies and the natural environment, viewing them as integral components of a dynamic system. This integrated approach is less common in traditional sustainability models.

(c) The hybrid framework can be adapted to non-luxury lodges as well as to account for the unique challenges and opportunities presented by such lodges, especially in ecotourism contexts. This flexible approach ensures that the framework addresses these lodges' specific needs and goals and enables a broader application, making it a valuable tool for a wide range of stakeholders involved in protected area management and ecotourism.

(d) The hybrid framework integrates various established social-ecological concepts and tools, such as SWOT analysis, causal loop diagrams, stakeholder analysis, and resilience assessment. This comprehensive approach allows for a more nuanced analysis of the complex relationships between ecological, social, and economic elements.

(e) Unlike many conventional sustainability models, which remain theoretical or abstract, the hybrid framework is designed for practical implementation. It provides a structured process that guides decision-makers in assessing, understanding, and improving the sustainability of luxury lodges. It helps translate sustainability principles into actionable strategies.

(f) The framework culminates in developing a managerial ecology model, which is a decision-support tool. This practical model aligns management practices with ecological dynamics, enabling stakeholders to make informed decisions that balance conservation and socio-economic considerations. This integration of ecological and managerial aspects is a distinguishing feature.

In summary, the proposed hybrid analytical framework goes beyond the scope of conventional sustainability approaches by offering a more comprehensive, integrated, and tailored approach to sustainability within the context of luxury game lodges in protected areas. It recognises the intricate dynamics of CHANS and provides a structured path for harmonising development with conservation. This approach is both practical and adaptable, making it a valuable resource for stakeholders in ecotourism and protected area management.

Conclusion

The article embarked on a journey to unravel the intricate dynamics surrounding the management of luxury game lodges in protected areas, where the delicate threads of biodiversity conservation, sustainable economic development, and community engagement come together. The original aim was to navigate these complexities effectively by introducing a comprehensive analytical framework considering CHANS's diverse components and interactions.In the realm of ecotourism, the management of luxury game lodges in protected areas presents a unique and complex challenge. These lodges, situated within delicate ecosystems, serve as hubs where the interests of biodiversity conservation, sustainable economic development, and community engagement converge. Adopting a comprehensive analytical framework that considers CHANS's diverse components and interactions is imperative to navigate these intricate dynamics effectively.

This study has endeavored to address this need by proposing a hybrid analytical framework specifically designed for luxury game lodges in protected areas but with a flexible approach and applicability to non-luxury lodges as well. Drawing from a rich tapestry of

existing SES frameworks and tools, the researchers have curated a comprehensive approach that captures the nuanced relationships between human societies and the natural environment within the context of these lodges.

The hybrid analytical framework begins with a Sustainability Context Assessment, offering a baseline understanding of luxury game lodges' ecological, social, and economic dimensions. Stakeholder Analysis and Interactions follow, recognising the pivotal role of diverse stakeholders in the sustainability equation. The researchers then propose the Key Drivers and Feedback Loop Assessment, which allows for unpacking the intricate forces shaping the dynamics of luxury game lodges. Vulnerability and Resilience Evaluation can assess the capacity of luxury game lodges to withstand and adapt to stressors. Identifying Key Systems and Subsystems, drawing from the SES framework, allows for the categorisation and understanding of the various components of luxury game lodges. This, in turn, informs the Analysis of Interactions and Interdependencies, elucidating how different elements interconnect within and beyond the luxury game lodge. The Managerial-Ecology Nexus Exploration probes the critical links between management practices and ecological outcomes.

Ultimately, the framework can integrate these findings into a bespoke managerial ecology model. This decision-making tool effectively empowers stakeholders with the knowledge required to make informed decisions, balancing conservation imperatives with socio-economic considerations. This hybrid analytical framework emerges as an invaluable asset in the quest for sustainability within luxury game lodges in protected areas. It equips decision-makers, conservationists, and communities with the tools necessary to harmonise the complex interplay between human societies and the natural world. Luxury game lodges can thrive and contribute significantly to the broader goals of ecotourism and global conservation efforts by fostering responsible management practices, promoting biodiversity conservation, and ensuring meaningful community engagement. Going forward, applying this framework with the specific outcome of developing a managerial ecology model will undoubtedly contribute to preserving the planet's precious biodiversity and the sustainable enjoyment of these remarkable ecosystems by future generations. It stands as a testament to our commitment to ensuring that luxury game lodges within protected areas provide unforgettable experiences and beacons of sustainability and conservation. In conclusion, the challenges posed by luxury game lodges in protected areas are complex. Still, with the right tools and approaches, these challenges can be navigated, and a harmonious balance created between human interests and preserving our natural world.

Acknowledgements

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