Roig Boixeda, P., E. Corbera, and J. Loos. 2025. Navigating a global crisis: impacts, responses, resilience, and the missed opportunity of African protected areas during the COVID-19 pandemic. Ecology and Society 30(4):28. https://doi.org/10.5751/ES-16352-300428

Research

Navigating a global crisis: impacts, responses, resilience, and the missed opportunity of African protected areas during the COVID-19 pandemic

Paula Roig Boixeda[1,2], *Esteve Corbera*[3,4] and *Jacqueline Loos*[5]

ABSTRACT. Protected areas (PAs) serve as key institutions for biodiversity conservation. Therefore, ensuring their long-term resilience in the face of adversity is essential. Using resilience thinking we investigate the institutional resilience of PAs across Sub-Saharan Africa. Specifically, we examine how the managers of 50 terrestrial PAs across 17 countries responded to the COVID-19 pandemic and identify factors that facilitated or hindered their capacity to respond. We show that although most PAs were negatively affected by COVID-19, these impacts varied heavily in magnitude and duration across contexts. Many of these impacts had not been addressed, with some response attempts falling short or resulting in unintended consequences. Funding gaps, lack of agency, and a lack of resilience-thinking appeared as barriers to the PAs' capacity to respond. Coping responses were the most common type used to navigate the crisis, whereas adaptive and transformative responses were rare. We interpret such predominant focus on short-term, coping responses as a sign of institutional resistance rather than resilience, and as a missed opportunity for transformation. We advocate for collective documentation and critical reflection on the effects and experiences of PAs emerging from COVID-19 and other shocks and conclude by emphasizing the need to mainstream resilience-thinking in conservation governance and management.

Key Words: *Africa; crises; impacts; protected areas; resilience; responses*

INTRODUCTION

After COVID-19 was declared a pandemic on 11 March 2020 (WHO 2020), experts feared significant impacts over the approximately 8000 Protected Areas (PAs) spread across Sub-Saharan Africa (SSA; Brooks et al. 2006, UNEP-WCMC and IUCN 2021). Academics and practitioners predicted it as the most serious challenge in decades for African PAs because of limited management capacity, increased pressures on natural resources, economic disruption, and loss of tourism revenue (Lindsey et al. 2020).

No African country escaped the disruptions of COVID-19, impacting public health, society, and economy (Mathieu et al. 2020). Despite recording fewer cases and deaths than other regions (Mathieu et al. 2020), the SSA region faced strict measures like the Global North, eased by late 2020 and early 2021 (Mathieu et al. 2020). Travel restrictions caused a 72% drop in international tourist arrivals to SSA in 2020 and 2021 compared to 2019 (WTO 2023). By 2022, tourism levels remained 42% lower than in 2019 (WTO 2023). Health restrictions led to reduced economic activity and altered production and consumption patterns (UNDP 2021). Both globally and in SSA, economic growth fell sharply in 2020, surpassing the 2008 financial crisis impact, and SSA faced its worst recession ever (IMF 2025).

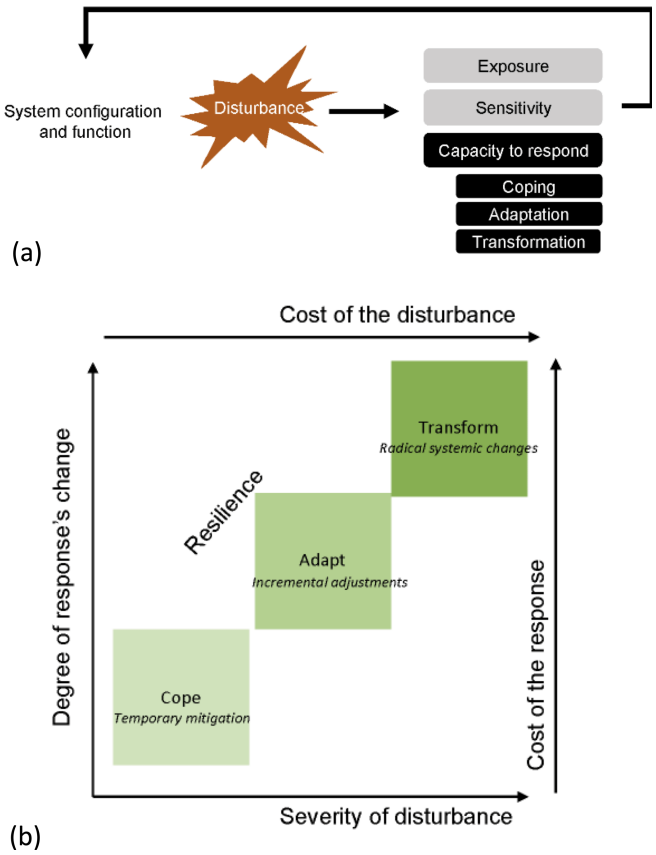
Reports and studies from multiple countries, including South Africa (Smith et al. 2021), Zimbabwe (Ndlovu et al. 2021), Tanzania (Shoo et al. 2021), and Namibia (Lendelvo et al. 2020) documented disruptions in PAs, highlighting reduced financial, managerial, and governing capacity, loss of local livelihoods and benefits, and increased biodiversity threats, as anticipated earlier by regional experts (Lindsey et al. 2020, Waithaka et al. 2021). Despite these early descriptive studies, a comprehensive analysis of how resilient African PAs were to COVID-19 is lacking. A comprehensive analysis of PAs' experiences during the pandemic, coupled with resilience thinking, can thus offer valuable lessons for future challenges.

Resilience is often misconstrued as staying unchanged during a crisis or quickly recovering (Walker 2020). In complex social-ecological systems like PAs, resilience can be defined as the ability to maintain functionality amid adversity (Walker 2020). This involves coping with short-term impacts and adopting long-term changes through adaptive and transformative processes (Fig. 1a; Béné et al. 2012, 2016, Walker 2020). Coping capacity refers to the system's ability to implement short-term, reactive responses that mitigate the immediate impacts of a disturbance, enabling it to "bounce back" from a disturbance (Béné et al. 2012, 2016). Adaptation involves long-lived, incremental adjustments, whereas transformation involves radical and systemic changes that endure beyond the initial shock (Béné et al. 2012). The suitability of these capacities relies on the disturbance's intensity and duration (Fig. 1b; Norris et al. 2008, Béné et al. 2016).

Resilience thinking suggests short-term coping is effective for minor disturbances, but high-intensity, long-term ones need adaptive responses. If a shock exceeds the system's adaptive capacity, transformation with radical changes is necessary. Different types of responses carry different costs and risks, with greater degrees of system change generally involving higher costs. Therefore, the chosen response often reflects a trade-off between the intensity and cost of the impact and the anticipated cost of the response itself (Béné et al. 2012). Resilience is a process that evolves during adversity and is not a fixed, observable outcome (Béné et al. 2016).

[1]Frankfurt Zoological Society, Germany, [2]Institute of Environmental Science and Technology, Universitat Autònoma de Barcelona, Spain, [3]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain, [4]Institute of Environmental Science and Technology & Department of Geography, Universitat Autònoma de Barcelona, Bellaterra, Spain, [5]Department of Botany and Biodiversity Research, University of Vienna, Austria

Fig. 1. (a) According to resilience thinking, the response capacity is one of the various factors that determine the capacity of a system to deal with a shock or stressor. Modified from DFID framework (DFID 2011). (b) This includes coping, adaptive, and transformative capacity linked to greater disturbance severity. Modified from Béné et al. 2016.



Through research exercises and literature reviews, resilience experts have identified various factors that appear to be characteristic of resilient social-ecological systems. Biggs et al. (2012), for instance, identified diversity, redundancy, connectivity, broad participation, or polycentric governance systems as key factors influencing resilience capabilities, among others. Kerner and Thomas (2014) later added attributes such as abundance and reserves, learning and collaborative capacity, autonomy, leadership and initiative, or situational awareness as key enabling factors of resilience (Kerner and Thomas 2014).

In this study we aim to explore the resilience of PAs in SSA, focusing on site-level dynamics as multi-level institutions (Cumming et al. 2015), offering insights into on-the-ground challenges and responses. Studying resilience in PAs is challenging because it only becomes clear during hardships (Berbés-Blázquez et al. 2022). like the COVID-19 pandemic. We address two main questions: how PAs in SSA responded to pandemic impacts and what factors affected their response capacity. Following resilience thinking, we expected adaptive or transformative changes to have occurred in PAs throughout or after the pandemic.

Our primary focus is thus on responses rather than impacts. Resilience thinking links responses to impacts, their magnitude, duration, and challenges faced by PAs due to COVID-19 (Fig. 1a/1b). We summarize impacts on SSA PAs during COVID-19 and analyze the stressor and shock regime. This description provides context and supports our objectives, but it is not exhaustive.

METHODS

Data collection

Between March and October 2022, the first author conducted 36 semi-structured interviews with site-level representatives of the management institutions of 50 terrestrial PAs across 17 SSA countries. Representatives of site-level management institutions (hereafter called "managers") included staff from government agencies and departments, conservation NGOs, and members of local community institutions, and were prioritized for their presence in the field, tacit knowledge, practical experience, and decision-making authority. We excluded the experiences and perspectives of higher-level governing bodies like regional or national headquarters. Despite recognizing the potential influence of personal values and subjective perspectives on manager's reports (McCool et al. 2015, Bobowski and Fiege 2023, Nikinmaa et al. 2023), we considered them a valuable source for obtaining a comprehensive and contextualized overview of PAs' experiences during the COVID-19 pandemic. Some of these managers oversaw several adjacent or similar PAs that shared the same management strategies and funding sources. Therefore, for analytical purposes, these adjacent or similar PAs managed by the same actor(s) were considered a single management unit.

We applied heterogeneous purposive sampling to recruit managers from diverse contexts and PA types (Table 1), ensuring good representation of subregions within SSA (South, East, West, and Central Africa) and governance types (government by government, by NGOs, and by community institutions; Borrini-Feyerabend et al. 2013, WB 2021). Sampling was restricted to terrestrial PAs managed for conservation in countries where English, French, or Spanish were official languages. Access to managers was facilitated through personal and professional networks.

Interviews focused on exploring the impacts of the COVID-19 pandemic on PAs, their causes and consequences, interactions with other shocks and stressors, and responsive actions taken (Appendix 1). Managers were also asked to reflect on the enabling or impeding factors of reported impacts and responses. Prior to interviews, contextual information about each PA was gathered to tailor interview discussions and help contextualize responses. Interviews aimed to capture site-level experiences for individual PAs, occasionally allowing insights for groups of adjacent PAs (n = 4) if managed as a single unit by the same group of actors with consistent strategies and funding sources. For analytical purposes, these sites were considered equivalent to a single PA unit.

The study's research and data management protocols, approved by the Research Ethics Committee of the Universitat Autònoma de Barcelona (reference: CEEAH CA06), ensured compliance with ethical standards. Managers provided free, prior, informed consent to participate. To maintain confidentiality, results are

Table 1. Characteristics of the management units considered in the study. n = sample size, % = percentage over the total sample of management units (n = 36, out of 50 PAs).

	Number	Percentage
Region		
East	7	19%
West	7	19%
South	12	33%
Central	10	28%
Governance arrangement (governing actor)		
Government	13	36%
NGO	11	31%
Community	12	33%
Location and accessibility		
Urban	3	8%
Rural accessible	8	22%
Rural remote	25	69%
Habitats		
Forests	19	53%
Savannah	8	22%
Mixed	5	14%
Other (wetland, desert, shrubland)	4	11%
Main funding sources for management		
Government	7	19%
Foreign public	7	19%
Foreign private	4	11%
Mixed (government & foreign)	7	19%
Tourism	9	25%
Other	2	6%
Gazettement date		
< 20 years	8	22%
20 to 50 years	18	50%
Before 1950s	10	28%

anonymized at the participant, PA, and country levels. Best practices for data security and storage were followed, including use of password-protected computers and databases.

Data analysis

Interviews were manually transcribed and coded using a combination of inductive and deductive approaches. We applied a deductive approach using predefined codes based on existing frameworks of PA management and resilience-thinking (Appendix 2), while also employing inductive coding to identify emergent themes, particularly in relation to response types and contextual factors. Coding was iteratively refined through multiple rounds. We used Quirkos to support coding and preliminary exploration of patterns in the transcripts. Coded information was then structured and organized in Excel spreadsheets for further analysis. We conducted qualitative content analysis focused on identifying recurring patterns in codes across the entire sample or specific subsets, and on exploring associations between coded impacts, causes, and responses. Contextual information from interviewees and online sources informed data interpretation. Impacts were coded into categories and further characterized based on their attributes, causes, valence (positive or negative implications for the PA based on the manager's assessment), duration, and magnitude. Duration and magnitude were coded on a three-point ordinal scale by the first author, informed by the manager's reflections.

For each identified impact, we sought passages that indicated whether a response had been implemented, attempted, and/or considered. Reported responses were thematically coded following an inductive approach into cohesive categories. Each response was then classified as coping, adaptive, or transformative (Table 2). These response types were not conceptualized as mutually exclusive, but rather as part of a continuum of capacity, with potential overlaps and interplay between them. For instance, some strategies may initially serve a coping function but evolve into more adaptive or transformative actions over time.

To support the exploration of patterns of association between impact magnitude and type of response, we visualized the data using scatterplots (Figs. 2 and 3). We assigned a disturbance strength to each reported impact (e.g., by multiplying impact duration and magnitude ratings) and plotted the result on the x-axis. Each impact (case) was then linked to the response type (coping, adaptive, or transformative) that was triggered, considered, implemented, or attempted. In cases with multiple responses, we only considered the one entailing the greatest degree of change.

Manager's insights were analyzed to identify factors associated with the occurrence or absence of impacts or responses. These factors, assumed to influence resilience, were inductively coded into cohesive themes.

RESULTS

COVID-19: the shock and the impacts

Except for one manager who administered a park without funding at the time, all managers revealed negative impacts of COVID-19 on their PAs. These impacts spanned various dimensions, including management inputs (tourism flows, finances, and human resources), management and governance processes (such as law enforcement or decision-making processes), and intended outcomes (i.e., reduced illegal activities or improved local well-being; Fig. 2). This typology helped structure the complexity of reported impacts and identity where resilience principles were challenged, whether at the level of resources, institutional funding, or conservation outcomes. Across 35 PAs, a total of 191 negative impacts were identified, categorized as small (37%), moderate (41%), or large (22%). Impact duration ranged from a few months in 2020 (30%) to ongoing or recently resolved in 2022 (43%). Among the recurring impacts were reductions in tourism, affecting all those PAs with some level of tourism prior to the pandemic (64% of the 36 PAs analyzed). Sites with no tourism activity reported no impact in this area. The most severe tourism-related disruptions were found in PAs with high dependency on tourism revenue or on tourism-linked incentives for local communities. In many cases, the duration of these impacts extended up to or beyond the time of our interviews in 2022. For example, one manager described how anti-poaching capacity improved during the pandemic, not because of strategic planning but because tourism activities that normally absorb enforcement personnel were suspended:

> *What happens in [the PA] in the tourism season, is that we lose maybe 70 anti-poaching scouts and government wildlife police officers … What was positive for us during COVID is that for almost two years we had all the scouts back on antipoaching duties … Now of course tourism has resumed, and everyone is getting back to normal* [SE06].

This illustrates how tourism reliance not only affected finances but also reshaped staff allocation, sometimes to the detriment of core conservation functions when tourism resumed. While COVID-19 had profound and lasting effects, previous shocks were described as more localized or expected. As one manager explained:

Table 2. Resilience encompasses coping, adaptive and transformative capacities. The table includes a description of these capacities based on the resilience literature along with the key identifiable characteristics used to code and categorize responses within each capacity, and the ordinal rating (representing the degree of change) used in the visualization graph.

	Description	Key identifiable characteristics for coding	Rating based on degree of change
Coping	Short-term measures aimed at addressing immediate needs, focused on recovery, rebuilding, and repair.[1,2,3]	Short term (lasts as much or less than the impact it addresses).	1
Adaptive	Longer-term adjustments and incremental changes that occur along the current system's trajectory.[1,2]	Longer term (lasts beyond the impact it addresses), AND Incremental changes (doing more of the same) or very minor qualitative changes (doing something different without it being a radical change).	2
Transformative	Longer-term radical changes that create fundamentally new structures, processes, or dynamics that move the system into a new development trajectory.[1,2]	Longer term (lasts beyond the impact it addresses), AND Major or radical changes (doing something different without it being a radical change).	3

[1] Béné et al. (2012).
[2] Galappaththi et al. (2019).
[3] Ungar (2018).

> *We have had many "covids" we could say, bomb blasts, insecurity, … Of course I would say covid is worse because covid is a new thing and it affected the whole world. Drought, politics, terrorism in the country … is something that comes and goes … it is something we always expect.*

This highlights the unprecedented, global nature of the pandemic and its extended disruption of tourism-dependent PAs in contrast to past shocks, which were often shorter-lived or geographically constrained.

Financial disruptions for PAs were reported by 81% of the managers, including reduced income from tourism or government allocations, donor restrictions on grant use, increased costs to implement COVID-19 protocols, and pandemic-induced inflation. Tourism disruptions tended to lead to more severe and prolonged impacts because of long-lasting disruptions in international arrivals. In contrast, donor restrictions, often implemented for a few months to prevent infections among PA staff and communities, led to shorter financial disruptions.

Compliance with COVID-19 prevention protocols and regulations, travel restrictions, and, to a lesser extent, funding disruptions, resulted in reduced staff availability and decreased presence in PAs and disrupted management and governance processes. Nearly half of the managers highlighted disruptions on law enforcement and community support/engagement activities. Disruptions were also reported for decision-making processes, procurement, and ecological monitoring and management in some PAs. The duration and intensity of management and governance disruptions varied depending on the cause of such disruptions. Funding losses from tourism collapse led to more substantial and enduring reductions compared to those caused by COVID-19 prevention measures, which typically resulted in small or moderate reductions lasting only a few months.

Intended PA outcomes, both social (local well-being) and ecological (control of anthropogenic biodiversity threats and natural resource use), were compromised in 72% of PAs, presumably due to COVID-19. Managers emphasized the challenges associated with trying to establish causal relationships between COVID-19 and these impacts because of the complexity of both phenomena. Adverse impacts on local livelihoods were mostly attributed to COVID-19 restrictions (in mobility, gathering, and others; 47%) followed by the collapse in nature-based tourism (36%). Increased threats on natural resources, such as bushmeat hunting, retaliatory killing, agriculture, grazing, firewood and medicinal plant collection, and mining were reported. These threats were associated with disruptions in local communities, as well as in management and governance processes outlined above. Despite their frequency, these increases were generally described as short-lived (lasting a few months in 2020) and of small to moderate magnitude. Only five managers reported large or long-lasting (i.e., > 1 year) increases in threats. Some managers reported temporary declines in threats (though short-lived) attributed to concerns about the spread of zoonotic diseases and reduced disturbance to wildlife from decreased tourism and human movement. Two managers reported having documented increases in wildlife abundance during the COVID-19 pandemic period but doubted their causal attribution.

Managers revealed that COVID-19 often co-occurred with other shocks, including socio-political (e.g., terrorism, armed conflict) and natural shocks (e.g., drought), which interacted with and compounded adverse impacts on PAs. These co-occurring and interacting shocks were sometimes viewed as even more detrimental to PAs than COVID-19, despite receiving less international attention and response from the international community.

Type of responses

Managers of 32 PAs reported responses to pandemic-triggered impacts, totalling 143 implemented (88%), attempted (5%), or intended but not yet implemented (7%). We grouped these responses into 23 categories (Table 3), with the most prevalent being budget reallocations, expense reduction, and budget reprioritization (50% of PAs), along with emergency fundraising (50% of PAs). These responses were primarily implemented to address financial disruptions caused by the pandemic (e.g., covering funding gaps left by affected tourism or other sources), but occasionally tried to solve negative impacts on local communities or the loss of informal PA staff salaries. Another highly prevalent response was the temporary adjustment of staff deployment and activities, often to comply with COVID-19

Fig. 2. Relative frequency, magnitude, and duration of negative COVID-19 impacts on protected areas (PAs) in Sub-Saharan Africa, as reported by 36 managers. Impacts are grouped into three overarching categories: PA inputs (finances and staff), PA processes (management and governance activities), and PA outcomes (local communities and biodiversity threats). Dot size indicates the relative frequency of each impact type, expressed as a percentage of the total 191 negative impacts recorded across the entire sample. Dot position reflects the average magnitude and duration, each categorized on a 3-point ordinal scale (Appendix 2). Colors distinguish sub-categories within each broad impact dimension. MGT & GOV = Management and governance, BIODIV. = Biodiversity.

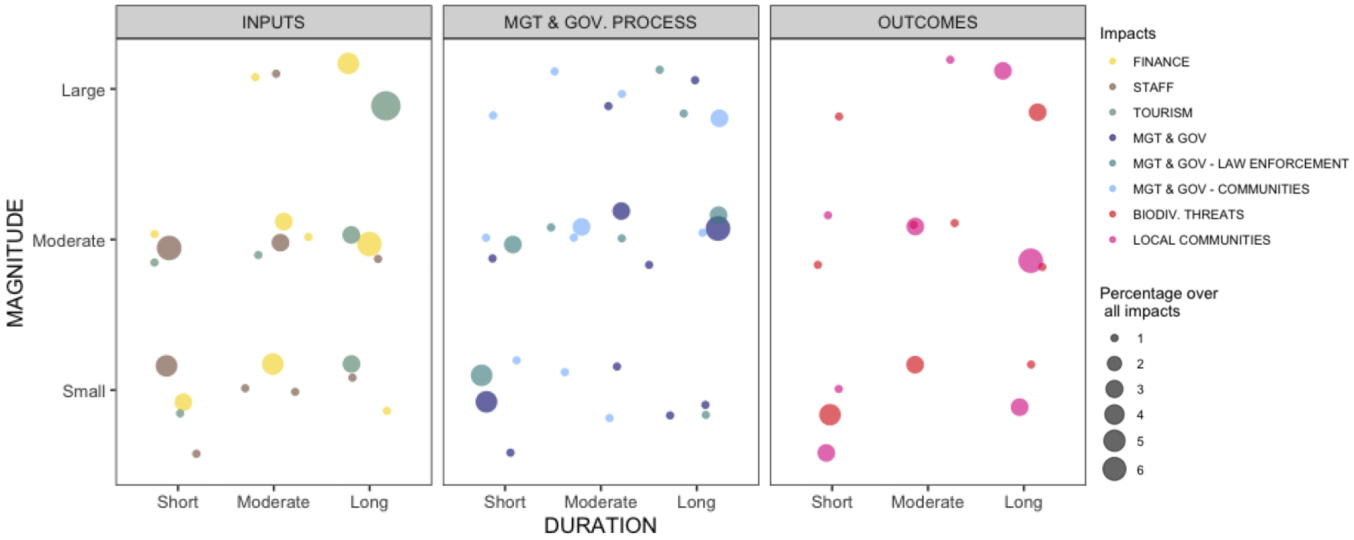
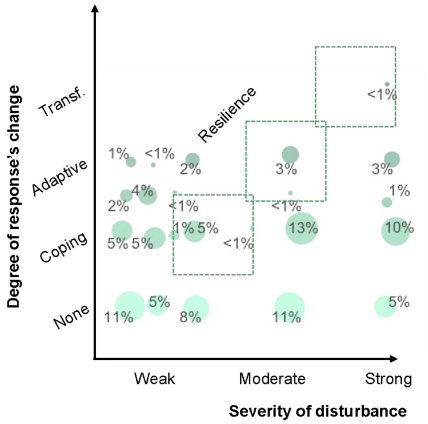


Fig. 3. Relationship between the severity of COVID-19 impacts on protected areas (measured on a 3-point ordinal scale) and the degree of change of the responses implemented and considered to address them. Degree of change orders response categories based on resilience thinking on an ordinal scale that ranges from lowest (no response) to highest (transformative responses). (a) The circles represent the relative frequency of reported impacts falling within each part of the graph, with percentages being calculated over a total of 191 distinct anticipated or realized negative impacts across 36 protected areas in Sub-Saharan Africa. The squared shapes show the position where most cases would be anticipated to fall according to resilience thinking.



restrictions. This included actions such as modifying patrol tactics, increasing the use of virtual meetings, or adapting strategies to meet and work with local communities while avoiding large gatherings via increased use of radio shows, door-to-door strategies, among others.

The evaluation of the effectiveness of implemented responses was inconsistent across managers and PAs. But at least a quarter of the identified responses were judged as ineffective or unintentionally negative for the PA by the interviewee, particularly those involving adjustments in PA activities. These adjustments were often deemed suboptimal, leading to underperformance or negative side-effects on other PA dimensions, such as increased expenses. Similarly, attempts to request for external financial support during the emergency were more frequently reported as ineffective, but these tended to affect PAs that were not used to receiving such support.

The majority (74%) of the 143 responses were categorized as "coping." Coping responses included budget reallocations, reprioritization of activities during the disturbance, temporary expense reduction, or temporary modifications in the deployment of activities. Of the coping responses (n = 106), the vast majority (94%) were reported as fully implemented with only a few instances of reported failure (6%).

Adaptive responses composed 13% of all responses, yet only 40% had been successfully implemented at the time of the interview. These adaptive measures included the creation of savings accounts and diversification of funding mechanisms to create redundancy in finances for future crises. However, interviewees admitted concerns about the likelihood of their continuation after the immediate stressor subsided. Similarly, at least two other

Table 3. Compilation of responses of protected areas to COVID-19 impacts identified through semi-structured interviews with 36 protected area managers across sub-Saharan Africa. Responses are inductively coded under broad themes (response) and categorized, based on resilience thinking, as coping (short-term), adaptive (beyond the shock, incremental), or transformative (beyond the shock, radical, and systemic). The table includes information on the number of examples (n) for each response and category and an indication of the impacted dimension they aimed to address (Tourism, Finance, Staff, Management and governance, Local communities, Biodiversity).

Response	Type	n	Dimension of impact addressed
Seeking or receiving financial assistance from external actors	Coping	(18)	• Finance
	Adaptation	(2)	• Local communities
	NA	(2)	• Biodiversity (threats)
Adjustments in the execution of PA (e.g., changes in team sizes, transport mode)	Coping	(18)	• Management and governance
	Adaptation	(1)	• Biodiversity (threats)
			• Staff (absenteeism)
Financial reallocation, reprioritization, and cost-cutting measures	Coping	(18)	• Finance
Implementation of health and safety protocols	Coping/adaptation	(14)	• Staff (disease)
Adoption or increased reliance on alternative strategies for offender identification and deterrence	Coping	(8)	• Management and governance
	Adaptation	(1)	• Biodiversity (threats)
Promotion of national tourism as a substitute for international visitors	Coping	(7)	• Tourism
	Adaptation	(2)	• Finance
Diversification of funding sources for the PA	Adaptation	(5)	• Finance
Adjustment of work shifts, work hours, and staff workload	Coping	(4)	• Staff (absence)
			• Management and governance
Provision of emergency assistance to local communities	Coping	(3)	• Local communities
	Coping/adaptation	(1)	
Increased reliance on communities for the implementation of PA activities	Coping	(4)	• Finance
			• Management and governance
			• Local communities
Negotiation with donors or tour operators for reduced funding restrictions or to address unpaid financial agreements	Coping	(4)	• Local communities
Development of long-term programmes to support local communities' livelihoods, well-being, and/or resilience	Adaptation	(3)	• Local communities
	Transformation	(1)	
Requesting of permission to operate or travel within legal constraints despite COVID-19 restrictions	Coping	(4)	• Management and governance
Use of existing savings or establishing a dedicated savings account	Adaptation	(2)	• Finance
	Coping	(2)	
Using or seeking supplies from local or national providers of materials and equipment	Coping	(2)	• Management and governance
	Adaptation	(1)	• Local communities
Communication with communities (open, close, and regular)	Coping	(3)	• Management and governance
Temporary relaxation of the enforcement of restrictions on natural resource use by local communities	Coping	(3)	• Local communities
Non-compliance with COVID-19 restrictions	Coping	(3)	• Management and governance
Managing dynamics and motivation of staff	Coping	(2)	• Staff
Seeking non-financial emergency support from external partners	Coping	(2)	• Management and governance
			• Biodiversity (threats)
Others	Coping	(1)	• Finance
- Use of manager's salaries to bridge funding gaps;	Adaptation	(2)	• Staff
- Moving away from tourism as an appropriate funding source for informal staff salaries and lobbying for the government to take care of those;			• Local communities
			• Biodiversity (threats)
- Consideration of a new approach for communal natural resource use through the establishment of communal fields for medicinal plant extraction			

managers observed a decline in support and initiatives from partners and governing actors as the COVID-19 crisis advanced, highlighting a potential loss of momentum, as expressed in the following quote:

> *... my experience has been that, at the onset of the pandemic, everyone is "Oh, let's try to do this, let's try to do that," both from the partners and park side. ... But as time passes, ... we noticed a reduction of the interventions* [SE04].

Only one response was classified as transformative, reported by an NGO-supported PA in southern Africa. Such transformation involved a shift in focus in their management approach, from a conservation-centric approach prioritizing law enforcement, wildlife management and monitoring, to one that equally prioritized the support and empowerment of local communities as key conservation partners. According to the interviewee, the PA, with a strong reliance on tourism, experienced a collapse in visitor numbers during COVID-19, leaving the local communities unemployed "from one day to another" "with no backup plan, no buffer, no compensation" [SE06]. This crisis served as a "wake-up call" and prompted reflection and self-awareness among managers and NGO directors. As a result, the NGO decided to strengthen fundraising efforts to secure additional, new, and long-term funds to implement new long-term programs that provide communities with additional income and enable participation in conservation efforts.

Eleven percent of responses were categorized as "coping/adaptive" because of uncertainty about their duration. For instance, the "implementation of disease prevention protocols"

Table 4. Compilation of barriers and enablers of responses to COVID-19 impacts identified through semi-structured interviews with 36 protected area (PA) managers across sub-Saharan Africa. These factors were inductively coded under broad themes. The table includes information on the identified factors grouped by themes. A description is provided for each of the factors, as well as the effect it was identified to have on the capacity to respond, either as an enabler (+) or barrier (-).

Theme	Factor	Description	Effect over response capacity
Funding	Amount and flexibility of financial resources	Quantity of financial resources available for PA management and governance and ability to reallocate or repurpose available funds quickly to address emerging priorities or unexpected challenges.	+
	Pre-existing support networks or capacity to access them	Existence of established relationships with actors and organizations (such as donors, NGOs) that can provide help and resources during challenging times.	+
	Reserves	Accumulation of funds set aside to be used only under extraordinary circumstances.	+
Tourism	Potential for revenue generation through domestic tourism	Ability to attract national residents to visit the PA when international tourism is not available.	+
Capacity to operate remotely	Access to virtuality and technology	Access and proficiency in using technology and digital tools, including infrastructure and skills.	+
	Established partnerships and collaborations with local communities	Established systems and mechanisms for remote collaboration with local communities, including efforts before the shock to build the capacity of local communities to implement management and governance activities.	+
Agency	Agency	Ability of PA management actors to exercise control, make choices and take actions to shape their response to adverse impacts.	+
Mindset	Mindset, perceptions, and resilience-thinking	Mindset and perceptions refer to factors such as situational awareness, understanding of the need for change, and beliefs about the challenges faced. Resilience-thinking refers to a way of thinking oriented toward self-reflection, critical and systems thinking, and forward-looking.	+
Disturbance	Constraints by the shock itself	Limitations or challenges for action that arise because of the nature of the adverse event.	-
	Stressor context	This refers to the context of stressors and shocks faced previously or simultaneously by the PA, including co-occurrence of shocks and stressors.	-

involved consistent but minor adjustments to existing protocols, making it unclear whether these changes would be temporary (i.e., coping response) or ongoing beyond COVID-19 (i.e., adaptive response). Another example was a PA providing fast-growing seeds to support local agriculture as an alternative to the tourism economy, which had become the primary driver of the local economy. Classification of this response depended on whether agriculture would continue post-tourism recovery, a detail unknown at the time of the interview.

No clear link was found between the magnitude of COVID-19 impacts and the degree of change in implemented or contemplated responses (Fig. 3). Most responses involved minor adjustments or no change, even when addressing impacts of small or moderate magnitude. Although a few examples of more substantial "adaptive" or "adaptive/coping" responses exist, their frequency did not consistently correlate with a specific impact intensity. This pattern was also absent for coping responses. However, the only transformative response identified aligned with a significant disruption triggered by COVID-19.

Barriers and enablers

Forty-four percent of the adverse impacts identified by managers remained unaddressed at the time of the interviews. Several factors influencing managers' capacity to respond to the impacts were revealed during the interviews (Table 4).

Funding-related factors were frequently cited as significant barriers to responsive action. Insufficient funds hindered responses, from coping to transformative. For instance, intentions to diversify PA funding through income-generating ventures were hindered by a lack of initial investment funds. In contrast, PAs that had secured financial savings prior to the crisis reported better coping capabilities. Flexibility and decision-making authority over financial resources were crucial, and their absence impeded the implementation of several intended coping responses such as budget reallocations or fundraising attempts.

Perceived and actual agency (e.g., control over financial resources or empowerment to decide and implement changes) also emerged as a key mediator of response capacity. Some managers viewed the capacity to operate their PA remotely, via technological solutions or strong partnerships and delegation to local communities, as crucial enablers to sustain governance and management activities while COVID-19 resulted in movement and gathering restrictions. For example, some community-led PAs that had trained local communities to mitigate human-wildlife conflicts were able to rely on their support when tourism revenues declined and PA staff had no means to intervene.

Interviews revealed that implementation and choice of responses to COVID-19 impacts were also influenced by decision makers' perception and thinking patterns. Certain responses were deemed unnecessary, unfeasible, or falling beyond PA's responsibilities and therefore were never implemented. For instance, managers sometimes attributed disruptions in local communities' livelihoods (coded in this study as impacts on PA outcomes) to broader national or regional economic disruptions triggered by COVID-19, absolving themselves and the PA of responsibility for finding solutions. During the interviews, managers reported feeling overwhelmed by the multifaceted impacts of the pandemic, which constrained their capacity to engage in broader strategic planning beyond short-term mitigation.

Managers acknowledged the immense challenge posed by severity and multidimensionality of the COVID-19 crisis. Concurrent restrictions on movement and gathering, disruptions to the economy, social context, and staff health and availability severely

constrained the range of responses that PAs could implement. Moreover, this challenging situation unfolded in the context of numerous significant pressures and stressors faced by PAs, including conflicts with local communities, concurrent shocks, and escalating biodiversity threats. Managers recognized that these simultaneous challenges prevented them from addressing issues beyond immediate and urgent needs. The metaphor "We are just putting out fires" [SE07] vividly captures the constant state of stress experienced by managers.

DISCUSSION

In alignment with published literature (Lendelvo et al. 2020, Lindsey et al. 2020, Ndlovu et al. 2021, Shoo et al. 2021, Smith et al. 2021, Waithaka et al. 2021), PA managers highlighted that the COVID-19 pandemic posed significant challenges to PAs across SSA, as evidenced by the negative impacts reported in our study, which align with previous claims, fears, and reports. Albeit recognizing other and potentially more detrimental shocks and stressors to the PA function and outcomes, managers were extremely challenged by the unforeseen nature of COVID-19, its multidimensionality, and global reach. Our study suggests that PAs in SSA were rarely spared from the shock, which triggered disruptions affecting management inputs (i.e., tourism flows, finances, and staff), management and governance processes (e.g., law enforcement or decision-making processes), and intended outcomes (i.e., reduction of illegal activities and improvement or maintenance of local well-being). Although the causal link between the pandemic and some of the reported impacts on PA outcomes may be debated, reported disruptions on inputs and processes appeared rather evident. Not all PAs were impacted to the same intensity. Many of the reported negative impacts were considered to involve small or moderate disruptions, yet one in five represented major negative impacts, and nearly half of the identified impacts persisted at the time of the study or had only recently been resolved.

Contrary to resilience thinking (Norris et al. 2008, Béné et al. 2016), we did not find an association between the severity of a reported impact and the type of action implemented or considered in response. Generally, the response of PAs to the pandemic-induced disruptions was limited. Many impacts remained completely unaddressed and when responses were put in place, these often consisted of coping strategies aimed at quickly rebounding from the shock. Coping strategies were widespread even when trying to address seemingly major disruptions in the PA system. The most prevalent response, for instance, involved the reallocation of existing funds and mobilization of additional resources to fill funding gaps and manage emerging needs during the pandemic. Although these coping mechanisms helped to stabilize the situation and avert the predicted collapses (e.g., Lindsey et al. 2020), the limited adoption of adaptive and transformative responses raises concerns from a resilience perspective (e.g., Walker 2020, Walker et al. 2020). The COVID-19 pandemic opened windows of opportunity, as temporary moments for change, such as increased collaboration with local communities and partners (Olsson et al. 2006). However, deeper transformative shifts, like reducing dependence on tourism, largely did not occur, possibly because the broader system remained in crisis mode. As the adaptive cycle suggests, such windows are brief and often close as urgency fades, which may explain the observed return to coping rather than transformative strategies. Resilience-thinking underscores the importance of crises as opportunities for reflection, reorganization, change, and "bouncing forward" (e.g., Young 2010, Walker et al. 2020, Berbés-Blázquez et al. 2022).

Similarly, many conservationists viewed COVID-19 as an unprecedented opportunity to question previous assumptions and refine existing PA practices and models (e.g., Fletcher et al. 2020, Hockings et al. 2020, Kaelo et al. 2020). However, the observed response pattern suggests a potential lack of capacity for self-organization and learning during crises (Walker 2020), which could be hindering opportunities for long-term improvement and resilience enhancement. Coping responses are not bad strategies, and we recognize that adaptive and transformative responses are not inherently preferable and have much greater inherent costs and risks for the system (Béné et al. 2012). Yet balancing the stability sought by coping strategies with the change inherent to adaptive and transformative responses is essential to navigating adversity (Béné et al. 2012, McCool et al. 2015). The skewed focus toward seeking stability (through coping responses) instead of embracing change revealed in our study indicates resistance rather than resilience (Walker 2020, Walker et al. 2020). Although we broadly aligned coping, adaptive, and transformative responses with the intensity of impacts, we acknowledge that change in complex systems is often non-linear. Even small disturbances can trigger major shifts if a system is near a threshold. The lack of correlation between impact magnitude and response type in our findings may reflect these threshold effects rather than simple inertia or capacity gaps.

We also recognize that the relative scarcity of adaptive and transformative change captured in this study does not necessarily imply that such changes are not occurring. These changes may have been overlooked by park managers during the interviews, especially as they might partly lack insights into decision-making processes and responses being undertaken at higher institutional levels. It is also possible that adaptive and transformative changes were still under consideration at the time of the interviews and thus unreported. In fact, some authors theorize that responses involving a lower degree of change precede and prepare a system for a deeper and more sustained response (Enfors-Kautsky et al. 2021). However, the findings and arguments of other researchers suggest that there is a tendency to relax and demobilize during a crisis as the threat and the pressure ease (Moraes et al. 2023) and that the implementation of coping responses reduces the potential for adaptive or transformative action (Enfors-Kautsky et al. 2021). Some PA managers recognized a loss of momentum in responsive actions to COVID-19 as the crisis progressed, while others feared that the reflections and lessons learned during the pandemic, such as the need to diversify funding and reduce the reliance on international tourism revenues would be forgotten and unaddressed as the crisis subsided.

The absence of a strong correlation between impact magnitude and response type also underscores the complexity of the decision making and responsive processes during crises. Whether and how a PA responds to the challenges brought about by a crisis is affected by various factors (Béné et al. 2012). From examining the experiences of managers during COVID-19, we identified funding, agency, support networks, and mindsets as recurrent factors influencing response capacity. As recognized by Biggs et

al. (2012), isolating the contributions of individual factors to resilience and response capacity is difficult and their separation is an analytical construct. These dynamics are shaped by initial conditions. PAs with prior financial buffers, local governance capacity, or institutional flexibility appeared better able to respond, regardless of impact severity. This path-dependency reinforces the importance of pre-crisis context in shaping resilience outcomes, including the characteristics of the greater social-ecological context within which PAs are found, which would deserve further exploration in future similar research.

Financial resources were a recurrent theme, reported as being key for implementing any sort of response, from coping to transformative. For instance, for PAs to be able to modify their deployment strategy to adhere to COVID-19 protocols without compromising its function, resources were needed to cover the financial requirements of deploying smaller teams in the field (e.g., fuel, food ratios). Similarly, to support local communities whose livelihoods had been disrupted by the pandemic, managers required additional financial resources. Even well-intended long-term responses, such as the creation of new income-generating activities often required initial financial investments. Existing networks of supporters, particularly NGOs or donors, proved to be an asset for PAs facing financial challenges and in need of emergency funding to address staff, process, or outcome-related impacts. This factor aligns with the concept of "connectivity" or "social networks" in resilience thinking (e.g., Biggs et al. 2012, Wither et al. 2021), which suggests that social networks can enable access to a wider range of resources during a crisis (Wither et al. 2021, Jones and Faas 2017).

Beyond having access to financial resources, flexibility and decision-making authority over these was key in enabling PAs to react quickly and respond to the new needs emerging from the crisis. The concept of agency or authority recurrently emerged in the narratives of PA managers as a key enabler (or barrier) for their response during the pandemic. Limited agency of PA managers was explicitly mentioned as an impeding factor to activate coping responses during the pandemic, a finding that aligns with earlier research (Kerner and Thomas 2014). Although not explicitly articulated by the interviewed PA managers, we contend that agency may also be required for adaptive and transformative responses. We argue that a greater sense of authority and agency among PA managers and local PA staff may foster a greater sense of ownership and responsibility (Ryan and Deci 2000). This, in turn, could potentially motivate them to embrace the associated risks and costs of adaptive and transformative responses, which are essential for long-term resilience, as discussed above (Béné et al. 2012, 2016). Having said that, and although our interpretation of the results points at the potential benefits of greater local autonomy of PA managers and staff in a crisis scenario, we acknowledge that PAs must be governed under considerations that include but are not restricted to resilience and crisis-scenarios.

Our analysis also points at the mindset of managers as a subtle yet significant factor in shaping PAs' responses to crises. How PA practitioners perceive and understand the world influences their conservation challenges (Bobowski and Fiege 2023) and therefore their decisions. Resilience experts increasingly recognize the pivotal role of individual mindsets (Luthe and Whyss 2015), particularly self-reflection, learning capacity, critical and future-oriented thinking for both enabling adaptation and transformation (Walker et al. 2002, Biggs et al. 2012, Svare et al. 2023). Yet, our findings suggest that many managers were overwhelmed by the scale and uncertainty of the pandemic, limiting their capacity for this kind of slower, strategic thinking. Although our focus is on site-level perspectives, broader organizational culture (Rollins 1993) and the surrounding social-ecological context also shape individual mindsets and influence the overall resilience of PAs, though this may need further exploration in future research. Importantly, not all transformation stems from planning. External shocks, such as policy shifts or technological innovations, can trigger abrupt system reconfigurations. This underscores the need for anticipatory capacity, not just reactive strategies. Organizational culture, encompassing the shared values, beliefs, formal and informal norms, and practices that shape decision making and behavior (Larsen and Valentine 2007), can either enable or constrain resilience. If organizational cultures within PAs are rigid, resistant to change, and prioritize stability, this can create barriers for adaptation and transformation even when the mindset of managers themselves would be conducive to resilience (Stirzaker et al. 2011). For instance, Biggs et al. (2011) highlight how PA procedures are often not designed to be adaptive, let alone transformative, making it challenging to embed reflection and resilience within those frameworks. Fostering resilience thinking among PA practitioners is crucial for enhancing the capacity to navigate and respond to crises effectively. However, it is equally important to cultivate a culture of reflexive, forward-looking thinking within PA organizations to support resilience-building efforts. Embracing principles of learning organizations (Michael 1995, Biggs et al. 2011) can facilitate this cultural shift and contribute to the long-term resilience of PAs.

CONCLUSIONS

In this article, we have leveraged the opportunity offered by the COVID-19 crisis to learn about the resilience of PAs from an institutional, governance, and management perspective. We have shown a predominant reliance on coping strategies to mitigate and absorb the immediate impacts of the COVID-19 crisis. Although these strategies played an important role in stabilizing the situation and averting otherwise feared catastrophic collapses, we contend that the investigated PAs across SSA missed an opportunity for self-reflection and learning and failed to adopt adaptive and transformative responses that could have otherwise led to long-term improvements and resilience enhancement. The magnitude and duration of the disruptions triggered by COVID-19 and the type of responses implemented or considered are not correlated, which underscores the complexities of decision making and responsive action during a crisis and highlights which factors such as funding, agency, support networks, and mindsets significantly influence the capacity of a PA to respond to adversity.

PAs operate in a complex stressor regime of concurrent shocks and stressors, with the COVID-19 pandemic constituting one among others (e.g., droughts, political and social turmoil, other pandemics). Being exposed to multiple stresses and their interactions can reduce the capacity of systems to respond (Young 2010), as experienced by some PA managers of this study. This complex regime of shocks and stressors bears significance for both the investigation and the management of PA resilience. From a research perspective, it accentuates the need for studies examining impacts and responses to any given shock or stressor to employ methodological and analytical approaches capable of grasping this complexity.

Although grounded in the specific context of COVID-19, many of the challenges and enabling factors identified, such as flexible funding, decision-making agency, and supportive networks, are relevant to other shocks that disrupt PA systems in similar ways. The lessons from this pandemic may be transferable to crises that affect key aspects of the system, such as financial inputs (e.g., tourism-dependent revenue) and operational capacity (e.g., staffing or fieldwork restrictions), including geopolitical instability or economic downturns.

Despite the intricacies involved with operationalizing complex and abstract resilience concepts and frameworks, resilience has demonstrated to be a valuable means to navigate the complexity of analyzing and comprehending the case of COVID-19 and PAs. From a management perspective, the complex regime of stressors faced by PAs in SSA underscores the importance of building general resilience, as opposed to resilience to specific risks and crises (Angeler and Allen 2016). This point was explicitly recognized by some managers who reported that certain responses to COVID-19 exacerbated the vulnerability to other relevant stressors and crises occurring prior, simultaneously, or immediately after the COVID-19 pandemic.

We strongly advocate for the mainstreaming of resilience-thinking within PA management and governance practice, both across individuals and organizations, considering it a first and indispensable step toward building resilience against future challenges. We simultaneously stress the need for resilience thinking to be embedded in the conceptualization and design of future research studies on the experiences of PAs and other conservation approaches with national, regional, and global shocks.

Author Contributions:

PRB, EC, and JL co-designed the study. PRB collected and analyzed the data, and wrote up the first draft of the article. EC and JL contributed to the draft and polished the last version.

Acknowledgments:

We are indebted to all protected area managers who contributed with their time and insights to this study, which was partly funded by the Frankfurt Zoological Society. JL received funding from the Robert-Bosch Foundation and EC acknowledges the support of ICTA-UAB María de Maeztu Unit of Excellence programme (CEX2019-000940-M).

Data Availability:

The data and code that support the findings of this study are available on request from the corresponding author, EC. None of the data and code are publicly available because it would compromise the privacy of research participants. Ethical approval for this research study was granted by the Research Ethics Committee of the Universitat Autònoma de Barcelona (reference: CEEAH CA06).

LITERATURE CITED

Angeler, D. G., and C. R. Allen. 2016. Quantifying resilience. Journal of Applied Ecology 53(3):617-624. https://doi.org/10.1111/1365-2664.12649

Béné, C., D. Headey, L. Haddad, and K. von Grebmer. 2016. Is resilience a useful concept in the context of food security and nutrition programmes? Some conceptual and practical considerations. Food security 8:123-138. https://doi.org/10.1007/s12571-015-0526-x

Béné, C., R. G. Wood, A. Newsham, and M. Davies. 2012. Resilience: new utopia or new tyranny? Reflection about the potentials and limits of the concept of resilience in relation to vulnerability reduction programmes. IDS Working Papers 2012 (405):1-61. https://doi.org/10.1111/j.2040-0209.2012.00405.x

Berbés-Blázquez, M., M. Schoon, K. Benessaiah, E. M. Bennett, G. D. Peterson, and R. Ghimire. 2022. Resilience in the times of COVID: what the response to the COVID pandemic teaches us about resilience principles. Ecology and Society 27(2):16. https://doi.org/10.5751/ES-13223-270216

Biggs, H., C. Breen, R. Slotow, S. Freitag, and M. Hockings. 2011. How assessment and reflection relate to more effective learning in adaptive management. Koedoe: African Protected Area Conservation and Science 53(2):1-13. https://doi.org/10.4102/koedoe.v53i2.1001

Biggs, R., M. Schlüter, D. Biggs, E. L. Bohensky, S. BurnSilver, G. Cundill, V. Dakos, T. M. Daw, L. S. Evans, K. Kotschy, A. M. Leitch, C. Meek, A. Quinlan, C. Raudsepp-Hearne, M. D. Robards, M. L. Schoon, L. Schultz, and P. C. West. 2012. Toward principles for enhancing the resilience of ecosystem services. Annual Review of Environment and Resources 37:421-448. https://doi.org/10.1146/annurev-environ-051211-123836

Bobowski, B., and M. Fiege. 2023. Elegant conservation: reimagining protected area stewardship in the 21st century. Ecology and Society 28(1):25. https://doi.org/10.5751/ES-13788-280125

Borrini-Feyerabend, G., N. Dudley, T. Jaeger, B. Barbara Lassen, N. Pathak Broome, A. Phillips, and T. Trevor Sandwith. 2013. Governance of protected areas: from understanding to action. WCPA Best Practice Protected Area Guidelines Series, 20. International Union for Conservation of Nature, Gland, Switzerland.

Brooks, T. M., R. A. Mittermeier, G. A. Da Fonseca, J. Gerlach, M. Hoffmann, J. F. Lamoreux, C. G. Mittermeier, J. D. Pilgrim, and A. S. Rodrigues. 2006. Global biodiversity conservation priorities. Science 313(5783):58-61. https://doi.org/10.1126/science.1127609

Cumming, G. S., C. R. Allen, N. C. Ban, D. Biggs, H. C. Biggs, D. H. Cumming, H. M. David, A. De Vos, G. Epstein, M. Etienne, K. Maciejewski, R. Mathevet, C. Moore, M. Nenadovic, and M. Schoon. 2015. Understanding protected area resilience: a multi-scale, social-ecological approach. Ecological Applications 25 (2):299-319. https://doi.org/10.1890/13-2113.1

Department for International Development (DFID). 2011. Defining disaster resilience: a DFID approach paper. DFID,

London, UK. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/186874/defining-disaster-resilience-approach-paper.pdf

Enfors-Kautsky, E., L. Järnberg, A. Quinlan, and P. Ryan. 2021. Wayfinder: a new generation of resilience practice. Ecology and Society 26(2):39. https://doi.org/10.5751/ES-12176-260239

Fletcher, R., B. Buscher, K. Massarella, and S. Koot. 2020. 'Close the tap!': COVID-19 and the need for convivial conservation. Journal of Australian Political Economy 85:200-211.

Galappaththi, E. K., J. D. Ford, and E. M. Bennett. 2019. A framework for assessing community adaptation to climate change in a fisheries context. Environmental Science & Policy 92:17-26. https://doi.org/10.1016/j.envsci.2018.11.005

Hockings, M., N. Dudley, W. Elliott, M. Napolitano Ferreira, K. MacKinnon, M. K. S. Pasha, A. Phillips, S. Stolton, S. Woodley, et al. 2020. Editorial essay: Covid-19 and protected and conserved areas. Parks 26(1).

International Monetary Fund (IMF). 2025. IMF Datamapper, World Economic Outlook. IMF, Washington, D.C., USA. https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD

Jones, E. C., and A. J. Faas, editors. 2017. Social network analysis of disaster response, recovery, and adaptation. Butterworth-Heinemann, Oxford, UK.

Kaelo, D., D. Sopia, D. Bell, R. Diggle, and F. Nelson. 2020. From crisis to solutions for communities and African conservation (commentary). Mongabay, 20 May. https://news.mongabay.com/2020/05/from-crisis-to-solutions-for-communities-and-african-conservation-commentary/

Kerner, D. A., and J. S. Thomas. 2014. Resilience attributes of social-ecological systems: framing metrics for management. Resources 3 (4):672-702. https://doi.org/10.3390/resources3040672

Larsen, K. A., and P. S. Valentine. 2007. The role of organizational culture in the on-ground implementation of tourism partnerships in protected areas. Organization & Environment 20(4):460-479. https://doi.org/10.1177/1086026607309391

Lendelvo, S. M., M. Pinto, and S. Sullivan. 2020. A perfect storm? The impact of COVID-19 on community-based conservation in Namibia. Namibian Journal of Environment 4:1-15. https://doi.org/10.64640/hdvy2h07

Lindsey, P., J. Allan, P. Brehony, A. Dickman, A. Robson, C. Begg, H. Bhammar, L. Blanken, T. Breuer, K. Fitzgerald, M. Flyman, P. Gandiwa, N. Giva, D. Kaelo, S. Nampindo, N. Nyambe, K. Steiner, A. Parker, D. Roe, P. Thomson, M. Trimble, A. Caron, and P. Tyrrell. 2020. Conserving Africa's wildlife and wildlands through the COVID-19 crisis and beyond. Nature Ecology & Evolution 4 (10):1300-1310. https://doi.org/10.1038/s41559-020-1275-6

Luthe, T., and R. Wyss. 2015. Introducing adaptive waves as a concept to inform mental models of resilience. Sustainability Science 10:673-685. https://doi.org/10.1007/s11625-015-0316-6

Mathieu, E., H. Ritchie, L. Rodés-Guirao, C. Appel, D. Gavrilov, C. Giattino, J. Hasell, B. Macdonald, S. Dattani, D. Beltekian, E. Ortiz-Ospina, and M. Roser. 2020. COVID-19 Pandemic. Our World in Data. https://ourworldindata.org/coronavirus

McCool, S. F., W. A. Freimund, and C. Breen. 2015. Benefiting from complexity thinking. Pages 291-326 in G. L. Worboys, M. Lockwood, A. Kothari, S. Feary, and I. Pulsford, editors. Protected area governance and management. ANU Press, Canberra, Australia. https://doi.org/10.22459/PAGM.04.2015.10

Michael, D. N. 1995. Barriers and bridges to learning in a turbulent human ecology. Columbia University Press, New York, New York, USA.

Moraes, A., J. Farinaci, D. Prado, L. Araujo, A. C. Dias, R. Ummus, and C. Seixas. 2023. What comes after crises? Key elements and insights into feedback amplifying community self-organization. Ecology and Society 28(1):7. https://doi.org/10.5751/ES-13773-280107

Ndlovu, M., G. Matipano, and R. Miliyasi. 2021. An analysis of the effect of COVID-19 pandemic on wildlife protection in protected areas of Zimbabwe in 2020. Scientific African 14: e01031. https://doi.org/10.1016/j.sciaf.2021.e01031

Nikinmaa, L., M. Lindner, E. Cantarello, B. Gardiner, J. B. Jacobsen, A. S. Jump, C. Parra, T. Plieninger, A. Schuck, R. Seidl, T. Timberlake, K. Waring, G. Winkel, and B. Muys. 2023. A balancing act: principles, criteria and indicator framework to operationalize social-ecological resilience of forests. Journal of Environmental Management 331:117039. https://doi.org/10.1016/j.jenvman.2022.117039

Norris, F. H., S. P. Stevens, B. Pfefferbaum, K. F. Wyche, and R. L. Pfefferbaum. 2008. Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. American Journal of Community Psychology 41:127-150. https://doi.org/10.1007/s10464-007-9156-6

Olsson, P., L. H. Gunderson, S. R. Carpenter, P. Ryan, L. Lebel, C. Folke, and C. S. Holling. 2006. Shooting the rapids: navigating transitions to adaptive governance of social-ecological systems. Ecology and Society 11(1):18. https://doi.org/10.5751/ES-01595-110118

Rollins, R. 1993. Managing the national parks. Pages 75-96 in P. Dearden and R. Rollins, editors. Parks and protected areas in Canada: planning and management. Oxford University Press, Toronto, Ontario, Canada.

Ryan, R. M., and E. L. Deci. 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist 55(1):68-78. https://doi.org/10.1037/0003-066X.55.1.68

Shoo, R. A., E. K. Mtui, J. M. Kimaro, N. R. Kinabo, G. J. Lendii, and J. R. Kideghesho. 2021. Wildlife management areas in Tanzania: vulnerability and survival amidst COVID-19. Chapter 5 in J. R. Kideghesho, editor. Managing wildlife in a changing world. IntechOpen, London, UK.

Smith, M. K. S., I. P. Smit, L. K. Swemmer, M. M. Mokhatla, S. Freitag, D. J. Roux, and L. Dziba. 2021. Sustainability of protected areas: vulnerabilities and opportunities as revealed by COVID-19 in a national park management agency. Biological Conservation 255:108985. https://doi.org/10.1016/j.biocon.2021.108985

Stirzaker, R. J., D. J. Roux, and H. C. Biggs. 2011. Learning to bridge the gap between adaptive management and organisational

culture. Koedoe: African Protected Area Conservation and Science 53(2):a1007. https://doi.org/10.4102/koedoe.v53i2.1007

Svare, H., M. Gjefsen, A. C. L. den Boer, and K. P. W. Kok. 2023. Learning systems and learning paths in sustainability transitions. Ecology and Society 28(1):22. https://doi.org/10.5751/ES-13868-280122

UN Development Programme (UNDP). 2021. Analysing long-term socio-economic impacts of COVID-19 across diverse African contexts. UNDP, Nairobi, Kenya. https://www.undp.org/sites/g/files/zskgke326/files/migration/africa/f5a32ba0e2fb38079-6e3596e0857ab63f2acb1300c5bb17aad9847e13f941c43.pdf

UN Environment Programme World Conservation Monitoring Centre and International Union for Conservation of Nature (UNEP-WCMC and IUCN). 2021. Protected planet: the world database on protected areas (WDPA). UNEP-WCMC and IUCN, Cambridge, UK. https://www.protectedplanet.net/en

Ungar, M. 2018. Systemic resilience: principles and processes for a science of change in contexts of adversity. Ecology and Society 23(4):34. https://doi.org/10.5751/ES-10385-230434

Waithaka, J., N. Dudley, M. Álvarez, S. Arguedas Mora, S. Chapman, P. Figgis, J. Fitzsimons, S. Gallon, T. N. E. Gray, M. Kim, M. K. S. Pasha, S. Perkin, P. Roig-Boixeda, C. Sierra, A. Valverde, and M. Wong. 2021. Impacts of COVID-19 on protected and conserved areas: a global overview and regional perspectives. Parks 27:41-56. https://doi.org/10.2305/IUCN.CH.2021.PARKS-27-SIJW.en

Walker, B. 2020. Resilience: what it *is* and is *not*. Ecology and Society 25(2):11. https://doi.org/10.5751/ES-11647-250211

Walker, B., S. Carpenter, J. Anderies, N. Abel, G. S. Cumming, M. Janssen, L. Lebel, J. Norberg, G. D. Peterson, and R. Pritchard. 2002. Resilience management in social-ecological systems: a working hypothesis for a participatory approach. Conservation Ecology 6(1):14. https://doi.org/10.5751/ES-00356-060114

Walker, B., S. Carpenter, C. Folke, L. Gunderson, G. D. Peterson, M. Scheffer, M. Schoon, and F. R. Westley. 2020. Navigating the chaos of an unfolding global cycle. Ecology and Society 25(4):23. https://doi.org/10.5751/ES-12072-250423

Wither, D., C. Orchiston, N. A. Cradock-Henry, and E. Nel. 2021. Advancing practical applications of resilience in Aotearoa-New Zealand. Ecology and Society 26(3):1. https://doi.org/10.5751/ES-12409-260301

World Bank (WB). 2021. Collaborative management partnership toolkit. World Bank, Washington, D.C., USA. https://www.worldbank.org/en/programs/global-wildlife-program/publication/collaborative-management-partnership-toolkit

World Health Organization (WHO). 2020. WHO Director-General's opening remarks at the media briefing on COVID-19 - 11 March 2020. WHO, Geneva, Switzerland. https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020

World Tourism Organization (WTO). 2023. International Tourism and COVID-19. WTO, Madrid, Spain. https://www.unwto.org/tourism-data/international-tourism-and-covid-19

Young, O. R. 2010. Institutional dynamics: resilience, vulnerability and adaptation in environmental and resource regimes. Global Environmental Change 20(3): 378-385. https://doi.org/10.1016/j.gloenvcha.2009.10.001

Appendix 1. Interview guide.

Introduction

[Thank the interviewee]

[Remind of key aspects of the research and ask for consent]

This research is done as part of doctoral research conducted at the Universitat Autònoma de Barcelona, Spain. It is supported by the Frankfurt Zoological Society.

The research aim is to get an overview on the impacts of COVID-19 on a broad variety of protected areas across sub-Saharan Africa as well as the responses implemented and draw lessons and recommendations for their resilience.

Your participation is very important to make this possible, but as previously said, it is entirely voluntary.

The interview will take about an hour-hour and a half. If at any point you have any questions or want to take a break or stop altogether, please let me know.

All the information you provide during the interview will be treated confidentially and it will be anonymized in written outputs, according to the preferences you stated prior to the interview.

[Ask for questions/concerns/comments]

Do you have any questions or comments?

[Request consent for recording]

Is it OK for you that I record this? The file will only be used for transcription purposes, accessed by me, securely stored under password, and will be deleted at the end of this research

Setting up context

[The objective here is to get enough information on the context: funding sources, governance, actors involved in management and decision-making, size, socioeconomic context, threats, isolation levels, etc] [To adapt based on the information gathered before the interview from public sources, information shared by interviewee and information already known by interviewer]

[To ask for more info on governance and management context:

- Details on governing and management of the protected area and recent changes
- Since when under current arrangement
- [NGO + Gov]
    - Role of each
    - Other NGOs?
- [Community governance]:
    - External support
    - Legislation constraints/support
    - Size/number villages]

Impacts

1.2.1. In what ways has COVID-19 affected the function, management and governance of your PA? [list all impacts described and the provided details regarding causes/consequences, duration, magnitude, and responses implemented to address]

1.2.2. [Refer to the impacts mentioned and *draw causal relationships between all impacts mentioned]*

- [Cause of problem] Is that a direct effect of the COVID-19 pandemic (or rather a consequence of something else in the system being affected)?
  - [Direct impacts]
    - What aspect of the pandemic caused that (health, mobility restrictions, other restrictions, economic)?
  - [Indirect impacts]
    - As a result of what else?
- [The consequences of the impact] What were the consequences of that?

1.2.3. [Intensity] Once all causal relations between impacts have been depicted, then ask for intensity of the impacts observed]

1.2.4. [Ask about the duration of impacts] How long did it that last? [Get as accurate as possible]

1.2.5. [Ask about the evidence available for each impact when not obvious] What is the evidence available for that impact? How do you know this impact has occurred to that intensity? [Anecdotal reports, Monitoring data, No data]

Responses

1.3.1. What type of actions were implemented at the management level to prevent or respond to the impacts of the COVID-19 pandemic?

[Ask the question broadly to capture responses that have been implemented for impacts that did not occur eventually or that have been missed and not reported. But after that, go through impacts for which no response has been mentioned to confirm whether no action was taken]

- [Response]
  - Was there anything that help you in putting this response in place? [only if not already mentioned by respondent]

- [No response]
  - What were the barriers for not responding?
  - Are you planning to do something about it? What?

- [Optional if time allows] Do you think that any of the responses you have mentioned [read them out to refresh memory of participant) will have negative consequences in the future (i.e., they had a positive effect now, but either had unexpected consequences or you think it will have negative consequences)?

Resilience

The previous questions should have served us to reflect on what has happened and how we have responded during the crisis. Now I would like to move towards some questions that relate to the resilience of the protected area.

1.4.1. [ONLY if effects are reported] Could you tell me three factors that you think have contributed to the PA being affected by COVID-19 pandemic?

1.4.2. Could you tell me three factors that you think have helped your PA to not be or be less affected by the COVID-19 pandemic?

1.4.3. Finally, do you think that going through the COVID-19 pandemic has weakened or strengthened your capacity to deal with future shocks? [Explain the answer, what type of shocks, and why]

Appendix 2. Coding scheme.

General coding scheme

1. **Impact**
    - 1.1. PA dimension affected
        - 1.1.1. Input
            - 1.1.1.1. Financial resources
                - 1.1.1.1.1. Income
                - 1.1.1.1.2. Expenses
            - 1.1.1.2. Human resources
                - 1.1.1.2.1. Presence
                - 1.1.1.2.2. Staff wellbeing
        - 1.1.2. Process
            - 1.1.2.1. Decision-making
            - 1.1.2.2. Procurement
            - 1.1.2.3. Law enforcement
            - 1.1.2.4. Support to/engagement with local communities
            - 1.1.2.5. Ecological management and monitoring
            - 1.1.2.6. Other
        - 1.1.3. Outcome
            - 1.1.3.1. Social
                - 1.1.3.1.1. Local livelihoods
                - 1.1.3.1.2. Other
            - 1.1.3.2. Ecological
                - 1.1.3.2.1. Illegal activities and natural resource use
                - 1.1.3.2.2. Wildlife and habitats
                - 1.1.3.2.3. Others
    - 1.2. Valence
        - 1.2.1. Increase
        - 1.2.2. Decrease
        - 1.2.3. Mixed
    - 1.3. Valence (negative vs positive for PA)
        - 1.3.1. Positive
        - 1.3.2. Negative
        - 1.3.3. Mixed
    - 1.4. Magnitude
        - 1.4.1. Small
        - 1.4.2. Moderate
        - 1.4.3. Large
    - 1.5. Duration
        - 1.5.1. Short
        - 1.5.2. Moderate
        - 1.5.3. Long
2. **Response**

2.1. Responses (thematic classification) (see Results)
2.2. Resilience classification
    2.2.1.Coping
    2.2.2.Adaptive
    2.2.3.Transformative

3. Factors/moderators (see Results)

4. Other crises
4.1. Type
    4.1.1.Health
    4.1.2.Sociopolitical
    4.1.3.Economic
    4.1.4.Natural
4.2. Interaction with COVID-19
    4.2.1.Yes
    4.2.2.No
    4.2.3.Unknown
4.3. Comparison
    4.3.1.Same
    4.3.2.Worse
    4.3.3.Less
    4.3.4.Unknown

Coding scheme to evaluate duration and magnitude of reported impacts

Characteristic	Assessment	Description	Ordinal rating
Magnitude	Small	The dimension/subdimension or process experiences only a minor disruption.	1
	Moderate	The dimension/subdimension or process experiences a substantial disruption but is not major.	2
	Large	The dimension/subdimension or process experiences a major disruption.	3
Duration	Short	The disruption lasts only a few months, always less than a year (i.e., only during 2020).	0.5
	Moderate	The disruption extends for approximately a year, covering a significant portion of 2021.	1
	Long	The disruption extends well over a year, may still be ongoing at the time of the interview (2022).	2