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Impacts of COVID-19 on conservation programs and research activities in Nepal

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ABSTRACT

The COVID-19 pandemic has had diverse impacts on global poverty, food security, and biodiversity conservation. While reports have highlighted both positive and negative effects of COVID-19 on biodiversity worldwide, the negative impacts have, in general, outweighed the positive ones. Despite initial reports and anecdotal evidence, there is a notable absence of country-specific empirical research assessing the COVID-19 impacts on biodiversity conservation. We documented the COVID-19 impacts on Nepal's conservation sector by analyzing the trends of tourist visitation and revenues in Nepal's protected areas, examining the progress on conservation programs at national and individual protected area levels, evaluating research and conservation activities, and recording the experiences of conservation practitioners. Our results, based on two online surveys and reviews of the government documents showed that the pandemic has had adverse effects on nature-based tourism, particularly leading to a significant reduction in visitation numbers to the protected areas. Furthermore, the progress of conservation programs and actions, and research activities in Nepal also suffered. Nevertheless, government agencies have maintained impressive progress in the planned activities. Protected area authorities continued to carry out critical conservation activities even during lockdowns, and most of the affected activities were resumed once the lockdowns were lifted. The study's result is critical in mitigating the impacts of global crises such as COVID-19 on protected areas and in enhancing their resilience for the future.

1. Introduction

Since the middle of 2020, the COVID-19 pandemic caused by a coronavirus (SARS-COV-2) has had a widespread effect on both people and nature (Manenti et al., 2020; Akinsorotan et al., 2021; Driessen, 2021). The impacts of COVID-19 on biodiversity have been dual, encompassing both positive and negative effects (Manenti et al., 2020; Akinsorotan et al., 2021; Driessen, 2021). Early reports on the impacts of COVID-19 on biodiversity speculated an increased wildlife foraging in settlements (Silva-Rodríguez et al., 2021), increased avian sightings in urban areas (Madhok and Gulati, 2022) as well as reduced air pollution (Shrestha et al., 2020; Bonardi et al., 2021). However, in some regions, the pandemic has led to escalated resource extraction activities, including illegal fishing, hunting, and poaching in protected areas (Buckley, 2020). Law enforcement and monitoring efforts for conservation have decreased

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(Corlett et al., 2020; Hockings et al., 2020a; b) and conservation budgets and research funding have been cut off (Bates et al., 2021). Surveys have shown that regular conservation activities in protected areas (PAs), such as the removal of invasive species (Manenti et al., 2020) and habitat restoration efforts (Miller-Rushing et al., 2021) have been put on hold. Moreover, the decline in tourism and visitation to PAs has affected conservation initiatives and impacted the income of local rural communities dependent on tourism (Corlett et al., 2020; Stone et al., 2021; Bates et al., 2021; Souza et al., 2021; Buckley and Chauvenet, 2022). Fieldwork conducted by researchers, managers, and students as well as data collection efforts by citizen science programs, have also been significantly impacted (Basile et al., 2021; Pennisi, 2020). Despite these global and regional overviews of COVID-19 impacts on biodiversity, it is equally critical to conduct country-specific empirical research, such as this study conducted in Nepal, in order to draw attention to the conservation sector and support the formulation of future recovery plans and programs with a specific focus on conservation efforts.

Nepal has not been immune to the impacts of the global COVID-19 pandemic. The Nepali Government implemented an extended lockdown which included the closure of land and air transportation, as well as the cancellation of public events and gatherings, in order to mitigate the spread of the coronavirus. The country has undergone a total of 225 days of lockdown, from March 24 to July 21, 2020 (slightly eased from June 21, 2020) during the first wave, and from April 29, 2021, to September 1, 2021, during the second wave of COVID-19 (source: <https://covid19.mohp.gov.np/>; Xinhua, 2021). Consequently, there was a halt in tourist visits to the country, including its protected areas (PAs). However, reports from newspapers such as the *Nepali Times* (2020), suggested that local people's entry into the PAs escalated during the lockdown. During the first month of the lockdown (March 24 to April 24, 2020), more cases of illegal extraction of forest resources, such as logging and fishing, were reported (WWF, 2020). Studies based on surveys of key personnel in PAs showed an increase in animal sightings within the PAs, as well as an increase in wildlife deaths in two PAs (Sagarmatha National Park and Chitwan National Park), and a rise in wildlife poaching (e.g., musk deer) during the lockdown (Koju et al., 2021; *Nepali Times*, 2020). Despite these early reports (Koju et al., 2021; Neupane et al., 2020) and anecdotal evidence of the impacts of COVID-19, there is a lack of comprehensive assessment of the impacts of COVID-19 on the conservation sector in Nepal.

Nepal manages a total of 20 protected areas (PAs), which include 12 national parks (along with their buffer zones), 6 conservation areas, 1 hunting reserve, and 1 wildlife reserve (Fig. 1). These PAs cover approximately 23.39 % of the country's total land, as designated under legal protection (DNPWC, 2021). More than 45 % of international tourists who visit Nepal typically explore at least one PA, highlighting the significant role PAs play in promoting nature-based tourism in the country (Government of Nepal, 2018). Tourism serves as a crucial source of foreign exchange and national income for Nepal, contributing \$590 million to the GDP, which accounted for 2.2 % of the GDP in the fiscal year 2017/18, before the onset of COVID-19 (Government of Nepal, 2019). When considering indirect economic contributions, the overall impact of tourism on Nepal's GDP reached \$2.4 billion (7.5 % of GDP) in 2019, supporting 1.16 million jobs (WTTC, 2021). Unfortunately, there is a lack of assessment on the effects of COVID-19 on the nature-based tourism sector in Nepal although the Nepal Tourism Board estimated a loss of US\$ 282 million in the country's tourism industry following the lockdown (Kunwar, 2021). It is also unknown how the decline in tourism reduces the revenue of PAs which in turn affects conservation budgets, programs, and the operations of PAs. Additionally, the impacts of COVID-19 on research organizations and the activities of researchers are also unknown. Therefore, it is crucial to gain a comprehensive understanding of the extent to which COVID-19 has affected conservation activities supported by the nature-based tourism sector in Nepal.

This study aims to assess the impacts of COVID-19 and the associated lockdown on Nepal's conservation sector, with a particular focus on nature-based tourism, using both primary and secondary data. The study is guided by two research questions: a) What are

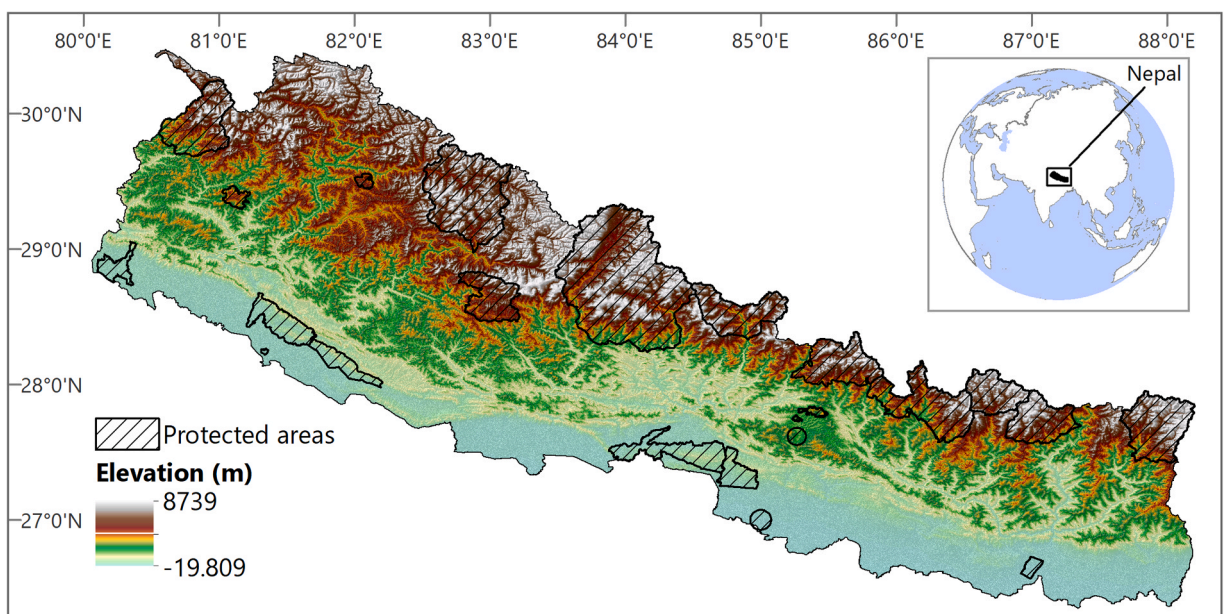


Fig. 1. Map showing the protected areas of Nepal.

trends in tourist visitation in PAs during and after COVID-19 lockdowns?, b) How has COVID-19 affected the programs and operations of Nepal's government agencies and non-governmental organizations involved in the conservation sector, and how have they responded to this crisis? To address these questions, we analyze the changes in visitation and revenue in Nepal's PAs, examine the progress of national-level conservation programs, assess research activities in PAs, and document the experiences of conservation practitioners in managing shocks like COVID-19. Through these analyses, we provide valuable insights into the effects of this crisis on Nepal's conservation sectors.

Our results are derived from the analysis of two online surveys and reviews of government documents. We assessed changes in conservation spending by analyzing the annual budget of the Department of National Parks and Wildlife Conservation (DNPWC), as well as the progress of the planned programs in both governmental and non-governmental sectors at the national level. At the protected area (PA) level, we examined the impacts on conservation efforts, management practices, and law enforcement activities through the analysis of survey questions. Furthermore, we explored variations in revenue collection from ecotourism and investigated any differences in conservation research and monitoring activities before and during the COVID-19 pandemic. Our study provides valuable insights into the challenges faced by conservation practitioners during times of crisis such as the COVID-19 pandemic. Our study stands out from existing literature on this topic as it utilizes primary data, whereas most previous papers (e.g., [Koju et al., 2021](#); [Laudari et al., 2021](#)) rely on administrative and secondary data.

2. Materials and methods

This study was conducted through an in-depth literature review and questionnaire survey carried out in Nepal. To conduct this study, a research permit from the Department of National Parks and Wildlife Conservation (DNPWC permit number: 292/078/079) was secured. Additionally, each questionnaire included an anonymous survey.

2.1. Secondary data collection

An extensive review of government documents, annual reports, and online surveys was conducted to collect data at national and institutional levels. The online surveys were administered among representatives of Non-Governmental Organizations (NGOs) operating in Nepal's conservation sector (referred to as conservation NGOs hereafter) and local parks officials. Data on international visitors were obtained from the Nepal Tourism Statistics ([MOCTCA, 2018; 2019; 2020; 2021; 2022](#)). Additionally, we analyzed the annual reports of the Department of National Parks and Wildlife Conservation (DNPWC) in Nepal ([DNPWC, 2017; 2018; 2019; 2020; 2021; 2022](#)) to extract the information on tourist visitations to national parks, budget allocation to various DNPWC programs, and the progress made in these programs over the last five years. The DNPWC is a government department responsible for conserving wildlife through the implementation of conservation programs in Nepal's protected areas.

2.2. Questionnaire surveys

We used a semi-structured questionnaire in an online survey administered to both conservation organizations and PA officials. Two separate sets of questionnaires were developed and distributed to these groups. A list of respondents including their phone numbers and email addresses, was compiled for both PA officials and conservation organizations. The survey was conducted online, and both questionnaires incorporated a semi-structured format consisting of open-ended and multiple choice as well as a five-point Likert scale (i.e., strongly disagree, disagree, neutral, agree, strongly agree) questions.

2.2.1. Representatives of conservation organizations

After identifying conservation organizations working nationally in Nepal and obtaining their contact information, we distributed an online questionnaire survey from 3rd to 31st March 2022. The survey was conducted among the heads or representatives of these conservation organizations. Prior to the main survey, a pre-test of the questionnaire was conducted among five conservation organizations. Feedback received from the participants was incorporated to refine the structure and clarify the wording of the questionnaire.

Out of the 27 surveys sent, we received 18 responses resulting in a response rate of 67 %. The main purpose of the survey among conservation organizations was to examine the impacts of COVID-19 on the funding situation and assess the progress of planned programs including research, awareness campaigns, capacity-building initiatives as well as human resource management (hiring and retention). Additionally, we aimed to document any coping mechanisms and innovative responses, employed by the organizations in response to the COVID-19 pandemic and associated lockdowns. The questionnaire consisted of four sections: organizational information, funding profile, impacts of COVID-19 on operations and programs, and coping and adaptation mechanisms to address the challenges posed by COVID-19 (Supplementary file S1).

2.2.2. Officials of protected areas

An online survey using Google Forms was conducted among the PA officials from all 20 PAs. The names and contact details of these officials were obtained from the Department of National Parks and Wildlife Conservation (DNPWC) and the National Trust for Nature Conservation (NTNC). The online response rate among PA officials was 65 %. The survey among PA officials aimed to assess the impact of COVID-19 on the implementation of regular activities within PAs. The questionnaire was divided into five sections: demographic details (including name, age, position, and years of experience in the PA), management and operational activities of the PAs,

information about law enforcement activities, park-people conflicts and the impacts of COVID-19 on tourism during the lockdown. To ensure the comprehensiveness of our questionnaire, we limited the surveys to the head of the PAs as they are best positioned to provide overarching information.

2.3. Data analysis

Statistical analyses and data visualization were performed using the R statistical software (R Core Team, 2022). To compare the data between the pre-COVID and COVID lockdown periods, we analyzed the monthly and yearly trends of tourist visitations to each protected area. Additionally, we examined the change in revenue amounts from 2017 to 2022 in Nepal’s PAs. For the data collected through questionnaire surveys, we conducted descriptive statistics, including percentages and frequency counts. Cross-tabulation was employed to assess the responses to specific questions, and a word cloud was created to visualize the collected responses. In the perception survey, we calculated the frequency of each response to the Likert scale.

3. Results

3.1. Change in international and domestic tourists’ visitation to PAs

Tourist arrival data showed a significant decline of 94.4 % in tourist numbers following the COVID lockdowns compared to the pre-pandemic period. In the fiscal years 2017/18 and 2018/19 before the onset of the COVID-19 pandemic, Nepal welcomed approximately 0.99 million and 1.22 million international tourists respectively. However, after the lockdown was announced at the end of March 2020, the number of tourist arrivals plummeted to 68,000 in 2020/21. In the latter half of 2021 and the first half of 2022, after vaccines became available, international tourists arrival in Nepal surged reaching 265,000. This represented a substantial increase of 389 % compared to 2020/21. Nevertheless, the number of arrivals remained 73 % lower than pre-COVID-19 levels despite the increase (Fig. 2). Before the COVID-19 pandemic, approximately 37.4 % and 35.0 % of total international tourists coming to Nepal in the fiscal years 2017/18 and 2018/19, respectively visited at least one protected area. However, during the COVID-19 period, both the overall number of international visitors and the proportion of visitors to protected areas declined significantly. In the fiscal years 2020/21 and 2021/22 only 14.2 % and 22.8 % of international visitors respectively visited at least one PA in Nepal.

Despite the challenges posed by COVID-19, the number and proportion of domestic visitors to PAs in Nepal have remained relatively stable. In the fiscal years 2019/20 and 2020/21, there was only a modest decline of 13 % and 12.4 % respectively, in the entry of domestic visitors into at least one protected area. However, following the COVID-19 lockdown, there has been a significant increase in

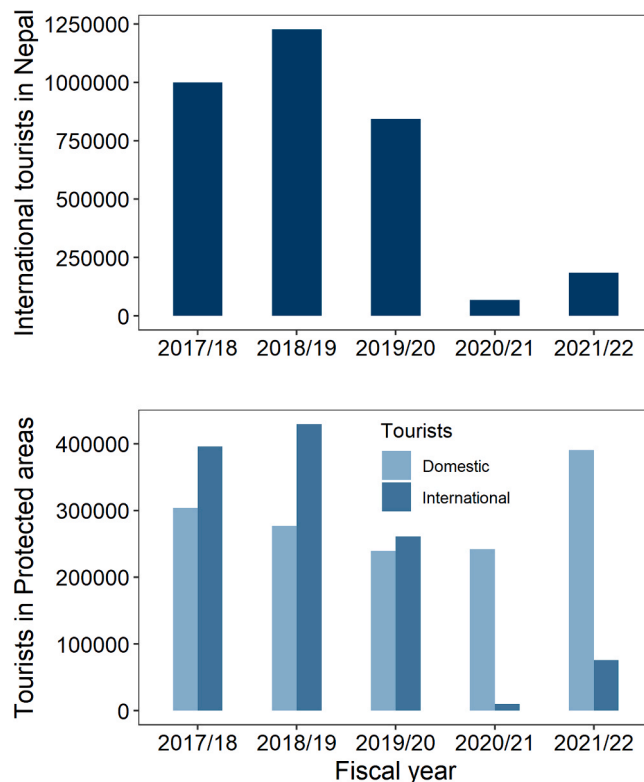


Fig. 2. International visitors in Nepal and international and domestic visitors in Nepal’s protected areas.

the number of domestic tourists visiting PAs. In the fiscal year 2021/22, the number of domestic tourists visiting PAs rose by 41.2 % compared to the pre-COVID-19 period.

The monthly data on international tourists visiting Nepal as well as domestic and international tourists visiting PAs showed a substantial decrease during the COVID-19 lockdowns (Fig. 3). Despite the expectation of a surge in tourist numbers during the peak tourist season in spring 2020, there was a significant decline in their arrivals. The number of tourists began to recover from September 2020 but experienced a subsequent decline due to the implementation of a second lockdown in May 2021. Subsequently, a pattern of increasing trends with some monthly variations emerged.

3.2. Change in tourist visitation to individual PAs

Although Nepal has 20 protected areas (PAs), only three PAs accounted for over 88 % of the total tourists visiting the entire protected area system in the country. Among these, the Annapurna Conservation Area received the highest number of tourists in Nepal with 181,746 visitors representing 42.3 % of the total followed by the Chitwan National Park with 142,486 visitors (33.2 % of the total) and the Sagarmatha National Park with 57,289 visitors (13.3 % of the total) in the fiscal year 2018/19. Consequently, these three PAs experienced the most significant impact in terms of visitation and revenue generation during the pandemic. In the fiscal year 2020/21, the number of international tourists visiting these three PAs saw a substantial decline. In particular, there was a 97.3 % reduction in Annapurna Conservation Area, 98 % in Chitwan National Park and 95.7 % in Sagarmatha National Park when compared to the figures from 2018/19 (Table 1).

Shivapuri-Nagarjun National Park, Chitwan National Park, and Koshi Tappu Wildlife Reserve were the most visited PAs in Nepal by domestic visitors. Coincidentally, the impact of COVID-19 on the flow of domestic tourists to these PAs was relatively less significant. In the fiscal year 2020/21, there was only a 39.4 % reduction in domestic visitors to Shivapuri-Nagarjun National Park and a 46.7 % reduction in Koshi Tappu Wildlife Reserve compared to the figures from 2018/19. This indicates a relatively resilient domestic tourist market for these PAs during the pandemic. Furthermore, the number of domestic visitors in Chitwan National Park, Langtang National Park, Sagarmatha National Park, Dhorpatan Hunting Reserve, Shey-Phokshundo National Park, Makalu-Barun National Park, Banke National Park, and Kanchanjunga Conservation Area increased in 2021/22 compared to 2018/19 (Table 1).

3.3. Change in revenue collection at PAs

During the COVID-19 pandemic, the total revenue collected from Nepal’s PAs experienced a significant decline. In the fiscal year 2018/19, the revenue amount reached Nepali Rupees (NRs) 765,366,000. However, this figure decreased to NRs 448,727,000 representing a 41.4 % reduction in the fiscal year 2019/20. The decline continued in the fiscal year 2020/21 with the revenue amount plummeting to NRs 150,732,000 marking an even larger reduction of 80.3 % compared to the fiscal year 2018/19. Following the easing of COVID-19 restrictions, there was a slight increase in revenue in the fiscal year 2021/22 compared to the previous two fiscal years. Nevertheless, the revenue amount remained 53.0 % lower than the amount collected in the reference fiscal year 2018/19 highlighting the substantial and enduring impact of the pandemic on the revenue generation of Nepal’s PAs.

3.4. Impacts on conservation programs and operations

The Department of National Parks and Wildlife Conservation (DNPWC) implemented various conservation programs at the national level, which were assessed based on their physical and financial progress. Both progress were measured as a percentage indicating the degree of accomplishment. In the fiscal year prior to the COVID-19 pandemic (2018/19), the mean physical progress percentage for these programs was 92.4 %. This figure marginally reduced to 91.8 % in 2019/20, further declining to 85.56 % in 2020/21. However, there was a slight improvement in physical progress in 2021/22, with the percentage increasing to 87.8 % on average (Fig. 4A). The

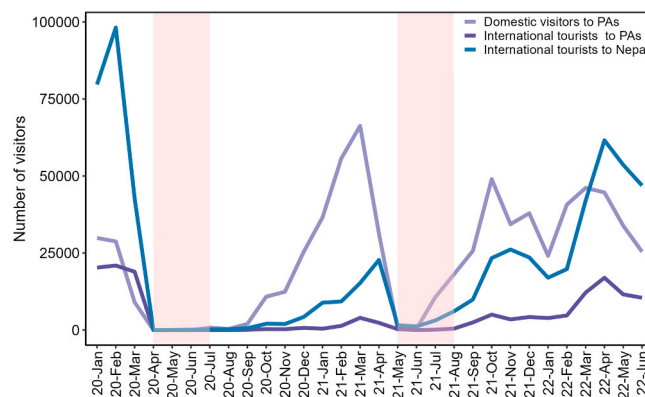


Fig. 3. Monthly number of international visitors in Nepal and international and domestic visitors in Nepal’s protected areas from January 2020–June 2022 (lockdown periods were shown in light pink shades).

Table 1
International and domestic visitors in Nepal’s protected areas in four fiscal years.

Protected area/Fiscal year	International				Domestic			
	2018/19	2019/20	2020/21	2021/22	2018/19	2019/20	2020/21	2021/22
Annapurna Conservation Area	181,746	103,782	4921	75,352	NA	NA	NA	NA
Chitwan National Park	142,486	102,954	2819	34,787	44,623	89,441	96,109	155,671
Sagarmatha National Park	572,89	31,533	2461	23,641	741	1103	1648	5282
Shivapuri-Nagarjun National Park	12,496	24,392	642	5325	156,321	100,605	94,778	155,707
Lantang National Park	12,132	8242	342	4150	5559	9203	4230	15,639
Bardiya National Park	8260	5506	269	3220	16,298	9754	7808	13,059
Manasalu Conservation Area	7655	5388	194	2266	NA	NA	NA	NA
Gaurishankar Conservation Area	2528	1523	30	496	NA	NA	NA	NA
Makalu Barun National Park	2057	1425	30	688	301	341	410	322
Kanchanjunga Conservation Area	806	584	42	181	0	24	11	60
Shey-Phokshundo National Park	578	426	10	174	1511	1242	1766	4256
Rara National Park	421	256	23	117	11,659	8575	10,217	11,451
Koshi Tappu Wildlife Reserve	388	198	17	123	18,385	10,903	9801	8114
Shuklaphanta National Park	329	172	8	150	5740	1603	2957	2579
Dhorpatan Hunting Reserve	104	75	20	66	319	245	5682	9855
Khaptad National Park	67	16	3	22	3653	730	1685	2187
Krishnasar Conservation Area	37	34	2	12	9490	5275	4525	6035
Api Nampa Conservation Area	28	7	3	16	10	2	3	3
Parsa National Park	15	14	5	8	379	378	147	769
Banke National Park	12	8	6	7	148	84	436	171

impacts of the pandemic were particularly evident in the program activities of the DNPWC, Hattisar (Elephant stable) Program, and National Park and Reserve Planning Program. These programs experienced significant decreases in physical progress. On the other hand, the decline in financial progress (expenditure) was less prominent compared to the decline in physical progress (Fig. 4B).

In the aftermath of the COVID-19 pandemic, the allocated budget for DNPWC has reduced significantly (79.5 % decrease) in 2021/22 compared to the budget of 2019/20. Not only was the funding of the government’s conservation department slashed, but funding of the non-governmental conservation organizations was also impacted. Regarding the effects of COVID-19 on conservation NGOs, more than half of these organizations experienced a decline in their budget in the fiscal year 2020/21 compared to 2018/19. The extent of the decrease varied between 5 % and 80 % depending on the size of the organization. Contrastingly, two organizations reported an increase in their income even during the pandemic, with one organization experiencing a 10 % increase and another a substantial 130 % increase. Representatives of the conservation organizations highlighted that COVID-19 has heightened uncertainty in funding, as mentioned by 52 % of the respondents, and has presented additional challenges to the financial sustainability of the organizations, as indicated by 36 % of the respondents (Fig. 5A). To cope with the reduced funding during the pandemic, more than a quarter of the organizations restored to cost-cutting measures such as slashing non-essential expenses (28 %), implementing a hiring freeze (26 %), even laying off staff (23 %) and reducing the staff salary (5 %) (Fig. 5B).

3.5. Impacts on local conservation activities

The impact of COVID-19 extended beyond the national-level programs and budgetary spending of DNPWC. Local field offices of protected areas (PAs) and conservation NGOs also experienced significant disruptions in their grassroots conservation activities. Our questionnaire survey among PA officials shed light on the specific activities that were heavily affected during the lockdown period, particularly those that required in-person meetings. These activities included awareness activities, training and workshops (medicinal herbs farming, nature guide training, environment education at school, wildlife week celebration, community awareness campaign,

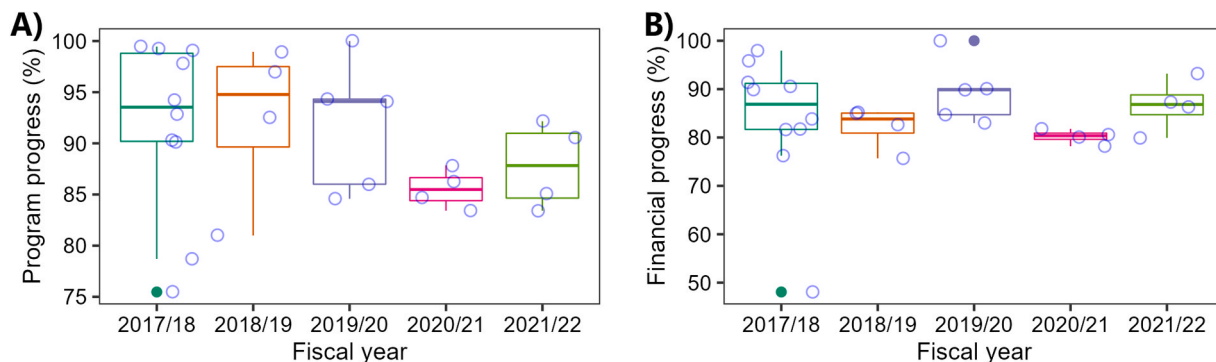


Fig. 4. Progress in planned programs of DNPWC, A) Program progress, B) Financial progress.

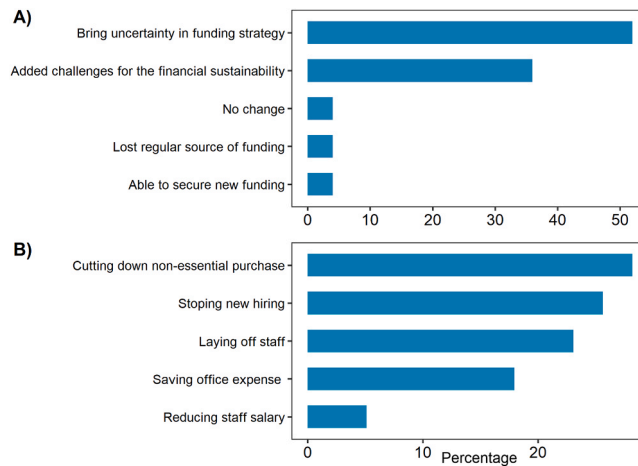


Fig. 5. Impacts of and responses to COVID-19, A) Impacts on funding of conservation organizations, B) Responses of conservation organizations to the COVID-19 pandemic.

waste management training, installing of signboard, waste bin), as well as law enforcement activities such as anti-poaching patrolling, monitoring illegal wildlife trade and regular monitoring work (Fig. 6A). Among these activities, certain programs emerged as high-priority conservation activities such as awareness programs, antipoaching patrolling, protecting endangered species, and regular monitoring and survey as indicated by the PA officials (Fig. 6B). For example, protecting endangered species was ranked extremely important by 54 % of PA officials, while 40 % considered it very important and 6 % ranked it somewhat important. Other key activities included awareness programs, anti-poaching patrolling, and regular monitoring and surveys.

Not only were the activities of government-managed PAs affected by the pandemic, but conservation NGOs also faced disruptions, leading to changes in their planned activities and working modality. A majority of conservation NGO representatives (>89 %) reported that their planned or funded conservation programs were impacted by the lockdown while 11 % reported no change. In some protected areas, the planned programs were paused during the lockdowns and completed immediately after the lockdowns were removed. This might be the cause behind some officers think COVID-19 has no impact on the conservation programs. Species-focused research and conservation programs were also significantly affected by the pandemic, particularly activities that require in-person engagements. Conferences, workshops, educational and awareness programs, and training events such as annual general meetings, capacity-building programs, result-sharing workshops, partnership meetings, and exchange visits were among the activities most affected, with 83.3 % of respondents stating that those events were either postponed (44.4 %), suspended (22.2 %) or put on hold (16.7 %) during the lockdown period.

In our survey among conservation NGOs, those who reported their activities were unaffected had shifted these activities into virtual mode. During the COVID-19 lockdown period in 2020 and 2021, 44.4 % of organizations implemented work-from-home arrangements for less than 6 months (1–6 months) while 55.5 % adopted a hybrid working model for more than 6 months (6–12 months) (Fig. 7A, B). When the working modality shifted to a work-from-home (WFH) or hybrid working model (combining WFH and in-office work), half of the representatives (50 %) reported a reduction in work efficiency. On the other hand, 11 % noted a slight increase in efficiency, while the remaining 39 % did not perceive any change or believed it was too early to evaluate. Representatives who reported a decrease in work efficiency cited various reasons, including the need for additional time to adapt to the new working conditions, hindered communication, reduced opportunities for discussions, delays in meeting deadlines, and inadequate monitoring mechanisms.

3.6. Impacts on research activities

COVID-19 has had a detrimental impact on conservation research activities carried out in Nepal's PAs. In Nepal, researchers are required to obtain research permission from DNPWC to conduct research in PAs. Before COVID-19, the number of research permits fluctuated, increasing by 50 % in 2017/18 compared to 2016/17 and then declining by 11 % in 2018/19 compared to the previous year. However, the proportion of decline from 2018/19 to the following two fiscal years during the COVID-19 period was even more pronounced. (Fig. 8). The decline can be attributed, at least in part, to the halt in field data collection activities during the peak period of the COVID-19 pandemic, which included two lockdowns. According to our survey with representatives of conservation NGOs, various long-term and short-term field research activities such as east-west highway survey of vultures, Bengal Florican monitoring in Nepal, urban bird count, local biodiversity monitoring and assessment activities, summer bird survey in Rara National Park, Cheer Pheasant survey, camera trap survey of fishing cats, school awareness events for fishing cats, and biodiversity assessment activities had to be either halted or postponed. Despite the interruption of field activities, researchers within conservation NGOs were engaged in other research-related tasks such as writing proposals, manuscripts, and reports; more than 50 % of the respondents mentioned their involvement in writing papers/reports, conducting webinars and awareness programs in virtual mode, seeking additional funding resources, and communicating with potential funders.

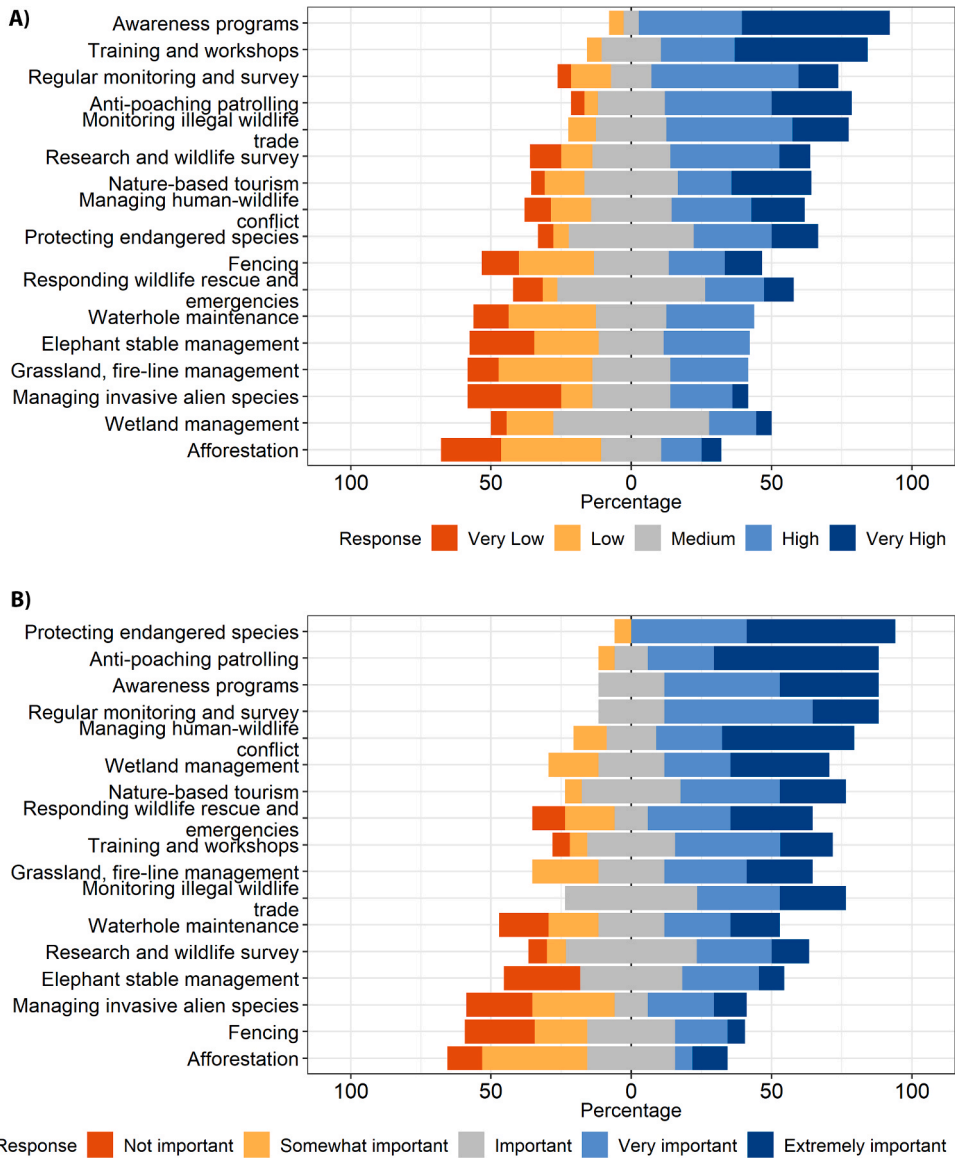


Fig. 6. Responses of PA officials, A) Impacts of COVID-19 on conservation and monitoring activities of PAs, B) Ranking of conservation and monitoring activities of PAs by PA officials. The percentage values represent cumulative responses of low (very low and low), medium and high (very high and high).

3.7. Perceptions of conservation practitioners on managing the future shock

The COVID-19 pandemic has had a significant impact on the financial conditions of the surveyed NGOs, with nearly 89 % of them experiencing negative effects. In preparation for a future pandemic or similar long-term disasters, most conservation NGOs expressed the need for an emergency or endowment fund and secure long-term funding rather than short-term to mitigate the impacts of such shocks (Fig. 9). They also highlighted the importance of saving and reducing operational costs to manage expenses effectively. Additionally, organizations recognized the potential of flexible working modality arrangements, where working hours are not confined to traditional office hours. They also emphasized the importance of appointing and empowering local project leaders for community-based activities to enhance work efficiency during challenging periods.

PA officials have recognized the need to allocate contingency funding to address unforeseen events such as the COVID-19 pandemic. The heavy reliance on tourism as a revenue source for PAs made the pandemic a significant disruption to their regular operational works, impacting the conservation and maintenance of the PAs. As a response, PAs have now prioritized diversifying their funding sources and developing sustainable funding mechanisms beyond tourism such as promoting enterprises based on non-timber forest products (NTFPs), exploring revenue collection from hydropower projects and the sustainable utilization of river-based

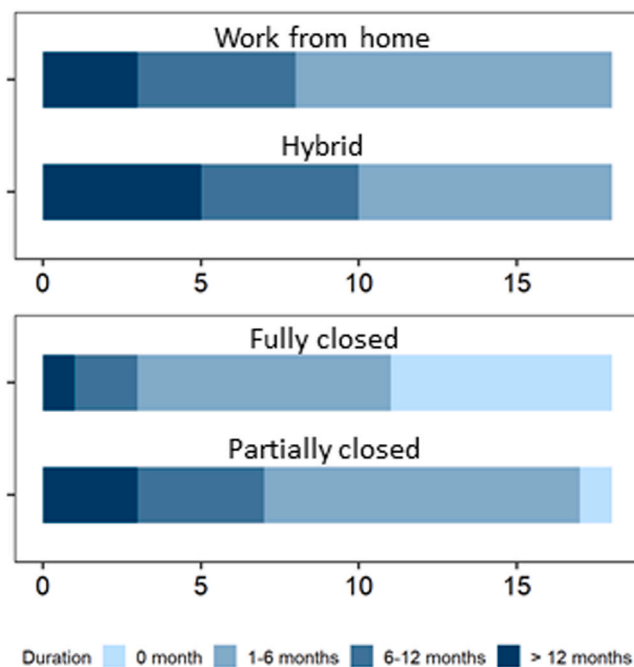


Fig. 7. Operations of Nepali conservation organizations during the COVID-19 period, A) Working modality, B) Operations during COVID-19.

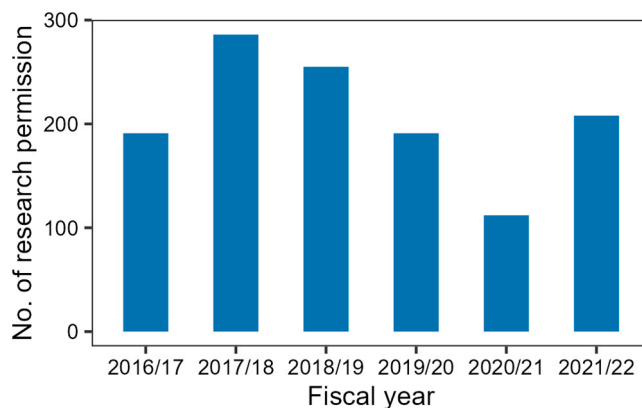


Fig. 8. Research permits granted by DNPWC in the last six fiscal years.



Fig. 9. Word cloud of the perceptions of conservation practitioners on managing the future shock.

materials such as sands and boulders. Other approaches expressed during the survey included wildlife farming, implementing Payment for Ecosystem Services (PES) schemes, engaging in carbon financing, and exploring emission-offsetting options. In cases where mobility restrictions and health protocols limit regular in-person patrolling activities, PA officials are actively seeking alternatives. This includes exploring the use of advanced spying or monitoring equipment, such as smart technologies to enhance enforcement-based activities.

4. Discussions

This study presents valuable empirical evidence on the impacts of the COVID-19 pandemic and the subsequent lockdowns on Nepal's conservation sectors. Particularly, it sheds light on the effects on nature-based tourism, the activities and operations of government agencies, and non-governmental organizations and conservation research. The insights gained from this study are of utmost importance for formulating effective recovery plans and programs within the conservation sector in Nepal and elsewhere, enabling better preparedness and resilience for future challenges or shocks similar to the COVID-19 pandemic.

The COVID-19 pandemic has had a profound impact on global human mobility with significant repercussions for nature-based tourism and conservation programs that heavily rely on tourism revenue. In the initial months of the pandemic, approximately 45 % of countries implemented total or partial border closures, severely limiting tourist arrivals (UNWTO, 2020). Nepal, like many other nations, implemented lockdown measures, which resulted in a substantial decline in the number of tourists visiting the country and the country's protected areas. Similar patterns of decline in the number of international tourists were observed in countries such as Bangladesh, Brazil, Namibia, Costa Rica, Ecuador, Indonesia, Germany, the USA, and Canada (Souza et al., 2021; Rahman et al., 2021; Spenceley et al., 2021). Similar to the protected areas in Nepal, many protected areas in Africa and Latin America (Waithaka et al., 2021) have also witnessed a sharp decline in international visitors due to the COVID-19 pandemic. The closure of borders, suspension of flights, and quarantine requirements have deterred international travelers from visiting protected areas, leading to a significant reduction in visitor numbers.

After the initial lockdown, there was a notable increase in the number and proportion of domestic visitors entering protected areas (PAs), although there was a temporary decline during the second phase of the lockdown. The second phase of lockdown was less stringent, allowing domestic visitors to continue visiting protected areas, resulting in a record number of domestic visitors during the fiscal year 2021/22, despite the lockdowns in May 2021. The visitor number in PAs presented here is incomplete because it does not include domestic visitors in conservation areas such as Annapurna and Manaslu, which receive a large number of domestic tourists for trekking and hiking. Our observation of increased domestic visitors to the PAs including urban recreational parks aligns with the national (e.g., Derks et al., 2020; Grima et al., 2020) as well as global level studies (Geng et al., 2021). The COVID-19 lockdowns and mobility restrictions have led to reduced social and physical contact, which can result in feelings of boredom, frustration, and isolation (Brooks et al., 2020). As a result, visiting nearby protected areas has become a preferred choice for individuals seeking outdoor activities, recreation, and nature experiences after prolonged periods of confinement at home during the lockdowns. With limited options for international travel, some people might have redirected their travel budgets toward domestic tourism, leading to an increase in visitation rates to PAs. Furthermore, the psychological and physiological impacts along with the concern for mental health may have contributed to the inclination to visit nearby parks and green spaces as a means of mitigating the negative effects of self-confinement (Geng et al., 2021; Grima et al., 2020).

Tourism in protected areas (PAs) contributes to the gross domestic product (GDP), generates foreign revenues, and supports PAs management activities in many countries (Balmford et al., 2015; Snyman and Bricker, 2018; Snyman, 2012). In Nepal, the PAs serve as the backbone of the tourism sector, making substantial contributions to the national economy, local livelihoods, employment opportunities, and foreign currency earnings (Zhu et al., 2022). Therefore, during times of crisis, such as the COVID-19 pandemic, the surge in domestic tourist numbers within PAs has played a pivotal role in sustaining nature-based tourism and raising awareness among the public about the importance of conservation and nature. Nevertheless, the increase in domestic tourist numbers has not been able to fully offset the revenue loss resulting from the decline in international visitors because there is a substantial difference in entrance fees between international and domestic visitors visiting Nepali PAs. Therefore, although the number of domestic tourists has seen a substantial increase, the proportion of revenue generated has not experienced a corresponding surge. A similar situation was observed in Yosemite National Park, which received 46 % fewer entrance fees in the fiscal year 2020 than in 2019 which reduced the funds for the projects in 2021 (Miller-Rushing et al., 2021).

The decline in tourism revenue resulting from the reduced number of international tourists during and after the COVID-19 pandemic has had a significant impact on various activities within PAs that heavily rely on tourism funding. This impact has been observed in terms of budget spending, program execution, conservation-related activities of government agencies, as well as the operations and funding of non-governmental conservation organizations. Prior to the pandemic, the programs of DNPWC were operated under five broad categories. However, in the fiscal years 2020/21 and 2021/22, only four key programs have remained operational with the Wetland Management Program being discontinued. The reduced funding in conservation organizations has not only impacted conservation efforts but also affected the job security and salaries of the employees working in parks who rely on a single source of income (Hockings et al., 2020a; b; Lindsey et al., 2020; Spenceley et al., 2021; Waithaka et al., 2021; Smith et al., 2021). The reduction in salaries or other facilities may potentially undermine the performance of the remaining staff involved in management activities and conservation actions (Corlett et al., 2020).

The number of research permissions granted for conducting research in the protected areas (PAs) of Nepal has shown a continuous decline from 2017/18–2019/20, but the situation has worsened due to the COVID-19 restrictions, resulting in a further decline in two consecutive years during COVID-19 period. This reduction in research activities within PAs may have had adverse effects on the career

prospects and economic conditions of researchers (MBZSCF, 2020; Johnson et al., 2020). Furthermore, it has led to a shift in research priorities away from conservation science and practices in the post-COVID period (Ramvilas et al., 2021), potentially impacting vulnerable species and ecosystems for years to come.

5. Conclusion

The COVID-19 pandemic has had significant impacts on nature-based tourism and the conservation sector in Nepal such as reduced visitor numbers and revenue, and halted conservation and research activities as observed in other parts of the world. While international visitor numbers have declined, there has been a remarkable increase in domestic visitors, particularly those from major cities, who have sought outdoor experiences in nearby PAs. However, the decrease in international visitors has resulted in a reduction in revenue and subsequent implications for the conservation sector in Nepal. During the pandemic, progress in conservation activities at both the national and individual PA levels was affected, but government agencies demonstrated commendable adaptability by maintaining progress in planned activities through different working modalities reaching around 85 % completion. Authorities of local PA also continued critical activities and gradually resumed affected activities after the lockdowns. Despite funding challenges and increased uncertainty, Nepali conservation organizations successfully employed adaptive strategies and remained functional at various levels.

These findings suggest several potential avenues for future action to mitigate the impacts of global crises such as COVID-19 on PAs and enhance their resilience. Designing PA activities to attract and engage domestic tourists can help sustain nature-based tourism during crises like COVID-19, as local tourists provide a form of insurance for PAs, offsetting economic losses caused by pandemic shocks. Regular training for PA staff in handling critical management activities during unexpected crises is essential. Relief plans should also consider the priorities of conservation organizations and actions to ensure their continued focus on conservation objectives.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.gecco.2023.e02628](https://doi.org/10.1016/j.gecco.2023.e02628).

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