Research article

Impact of COVID-19 pandemic on tourism, income of local communities and biodiversity conservation: Evidence from Burunge wildlife management area, Tanzania

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A B S T R A C T

The COVID-19 pandemic has resulted in various negative repercussions worldwide in terms of biological conservation, the tourism sector and socio-economic welfare. The purpose of this study was to assess the impact of the COVID-19 outbreak on socio-economic activities, income from the tourism sector, alternative sources of income adapted by the local communities adjacent to the Burunge Wildlife Management Area (WMA) as a means of survival, and its implications for biodiversity conservation. To assess tourism status, socio-economic activities and alternative livelihoods, interviews, semi-structured questionnaires, focus group discussions (FGDs), and key informants' consultations were conducted on 264 respondents, of whom 53 % (n = 140) were men and 47 % (n = 124) were women. Secondary data were obtained from soft and hard copy reports through an extensive literature search in order to comprehend the implications of COVID-19 and alternative livelihoods in biodiversity conservation. 90.5 % (239) of respondents reported being seriously affected by the emergence of COVID-19, while 9.5 % (n = 25) were not affected by it. Some of the impacts of the COVID-19 as pointed out by the respondents included deflation (91.7 %, n = 242), a decline in the number of customers (91.7 %, n = 242), whereas others lost jobs (5.7 %, n = 15). In the case of the Burunge WMA authority, revenue collection (mainly from the tourism sector) declined by 32.5 % and 76.4 % for the years 2019/20 and 2020/21, respectively, as compared to the revenue obtained in the year 2018/19 before COVID-19. During the pandemic, local communities adapted to several alternative sources of income while others intensified their former ones mainly being agriculture, fishing and livestock keeping. It is important for local communities, especially those adjacent to protected areas, to have diversified means of income that are environmentally and socially sustainable, such as fish farming and beekeeping, to reduce the impacts of unanticipated crises such as COVID-19.

1. Introduction

The World Health Organization (WHO) officially declared COVID-19 as a global pandemic on March 11, 2020 [1]. The global impact of the COVID-19 pandemic has been experienced by each industry. Its effects on the health, ecology, and socio-economic sectors, to name a few, have disturbed regular patterns of life [2,3]. COVID-19 has had a significant impact on the economies of many countries, particularly those in the global south and on the African continent. According to the [4], developing countries are

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expected to lose approximately 220 billion US dollars as a result of the impact on the operation of various sectors such as education, health, food security, and employment issues, with approximately 3.3 billion people losing their jobs at this time. Many Africans' living conditions have been dubious for years, but COVID-19 has aggravated the situation [5].

The wildlife sector has also experienced the impact of the COVID-19 pandemic. Tourism industry is among the sectors which are at high risk not only because of outbreak of disease but political turmoil, terrorists' attacks, natural calamities and other disturbances. Some studies have highlighted the benefits of the pandemic on biodiversity conservation, including a reduction in human visitation and pollution within and surrounding protected areas; which appears to maintain natural ecosystems and create a suitable setting for wildlife growth [1,6]. For example, Nepal documented a decrease in carbon emissions and hence air pollution, as well as reduced stress to wildlife due to a decrease in human traffic within the protected and conserved areas [1]. COVID-19's importance in wildlife protection cannot outweigh its negative consequences. The existence of protected and conserved areas was challenged by a decline in donor finances, the failure of numerous development initiatives, and a lack of conservation considerations in government budgets during the crisis. A large portion of the money was diverted to combat and stop the spread of the COVID-19 pandemic [7,8]. However, few donors were still offering funds to run vital operations in some National Parks (NPs) during the crisis. For instance, Serengeti NP has been donated 20 million $ US (by FZS, Germany) to keep the park infrastructure and rangers working during the period when the park did not receive visitors. The imposition of lockdown and travel restrictions was sufficient to demolish all plans and methods for achieving projected managerial and developmental goals in different areas, including wildlife [9].

Wildlife Management Areas (WMAs) in Tanzania have faced similar issues due to the COVID-19 pandemic [10]. According to Tanzania's 1998 Wildlife Policy, WMAs are areas in the villages land that are only dedicated or set aside for wildlife conservation. This approach was designed to create a win-win situation between the local communities adjacent the protected areas and wildlife. WMAs were introduced to allow local communities to benefit from conservation activities while they also manage and protect the wildlife [11]. Due to the total reliance on tourism activities to manage these places, the occurrence of COVID-19 has had a significant impact on many operations and plans [12]. The earnings generated by tourism and other investment projects within and around the WMA dwindled. According to Burunge WMA Authority (JUHIBU) leaders, the Burunge WMA, which is the main focus of this research, has faced various obstacles that have slowed the attainment of annual objectives to the point where several activities, including patrols, have been impacted. The effects were felt not just within the protected areas, but also in the surrounding indigenous and local people, who relied fully on this WMA, either directly or indirectly [10,13]. The failure of the market for numerous items, poor demand for produced goods, a dramatic drop in clients, and job loss were among the factors that affected the livelihoods of many people living adjacent the WMA [12,14].

Despite the availability of information about the implications of the COVID-19 pandemic on protected and conserved areas, as well as recommendations on what should be done to mitigate its effects [10,12], very little is known about the degree to which these effects changed the patterns and livelihoods of communities, particularly those who rely entirely on protected zones. Furthermore, there is limited data available on the alternative sources of revenue employed by local residents adjacent to the protected areas to earn income for their living during the COVID-19 pandemic and its implications for biodiversity conservation (ecological impact). Therefore, there is a need for more extensive studies to explore the aforementioned issues for the well-being of not only protected areas but also local communities adjacent to the protected areas.

Various livelihood models have been used in different studies to understand the livelihood approaches and strategies used by communities to cope with emerging shocks, trends, and calamities within their societies. Some of those models include the livelihood vulnerability framework (LVF), livelihood approach (LA), and sustainable livelihood approach (SLA), which has mainly been used in this study [15–18]. All these models explain that livelihood outcomes are measured by different societal aspects, including food access, human well-being, and access to other public services. Moreover, they understand the consequences of shocks, calamities, trends, and culture in disturbing the availability of physical, social, human, natural, and financial assets that play a key role in the sustainability of livelihood dimensions [16,17]. In this study, the SLA is applied to understand the impact of COVID-19 on the sustainability of livelihoods, especially by focusing on the ability of the local community to absorb and cope with the repercussions caused by the pandemic.

The aim of this research was to assess the effects of the COVID-19 pandemic on the tourism industry and the socio-economic activities of local communities around the Burunge WMA. In addition, the study aimed to understand the alternative sources of income adapted by local communities to survive during the COVID-19 pandemic and their implications for biodiversity conservation. This study is important because it provides baseline information on the magnitude of the socio-economic repercussions of the COVID-19 pandemic while also shedding light on alternative sources of revenue adapted by local communities adjacent to the Burunge WMA during the crisis. The results of this research will assist responsible authorities and communities in adopting effective approaches and strategies to prevent the effects of unexpected tragedies such as COVID-19, as well as modifying some policies for the interest of protected areas and nearby local communities.

2. Materials and methods

2.1. Conceptual design

The occurrence of the COVID-19 pandemic affected various facets of the livelihoods of the local communities adjacent to the protected areas. The livelihood assets, including economic, social, and human assets, were disrupted, leading to increased social vulnerability in different aspects of human beings. To understand the link between livelihood assets, the COVID-19 pandemic, and the alternative strategies adapted by the communities as a means of recovering and coping with the pandemic, the SLA framework was

adopted [15,18]. The SLA was a preferred model because it provides a way toward critical thinking about the livelihoods of marginalized groups, including most local communities adjacent to the protected areas in Africa [16–18]. It acts as a starting point for reflecting on and analyzing the factors affecting livelihoods, including pandemics like COVID-19, their interactions, and outcomes in a particular setting at large [18]. Moreover, according to SLA, the optimal availability of social, financial, natural, and human assets improves the sustainability of livelihoods, and thus the disruption of any asset on the list may in one way or another jeopardize the stability of the community [15,19]. The model goes beyond the aforementioned context to include local community perceptions on the different issues that may even override their usual basic requirements. As pointed out by Ref. [19], for a livelihood to be sustainable, it has to cope with and recover from shocks and stress like COVID-19 while maintaining its assets and capability now and then. Thus, the main idea behind the SLA approach in this study was to appraise how the COVID-19 pandemic affected the livelihoods of local communities adjacent to Burunge WMA. Moreover, it shows how the local communities coped with and adjusted to the shock (COVID-19) to make their livelihoods sustainable. Fig. 1 shows the conceptual framework as modified from Ref. [19].

2.2. Study area

This study was conducted across three villages that were purposefully selected, namely, Kakoi, Maweni, and Mwada found adjacent to the Burunge Wildlife Management Area (WMA) within the Tarangire-Manyara Ecosystem, from September to October 2021. The villages that were included in this study benefited from the Burunge WMA directly or indirectly. This WMA was selected because of its significant conservation role it provides. Burunge WMA is very crucial as it makes a part of a wildlife corridor connecting Tarangire and Manyara National Park. Also, the area is close to UNESCO world heritage sites which are Serengeti National Park and Ngorongoro Conservation Area. The Burunge WMA has a size of 617 km², of which 280 km², is reserved for conservation activities. The Burunge WMA is found in the Tarangire-Manyara Ecosystem (TME) between latitude 3.94°S to 3.66°S and longitude 35.73°E to 35.97°E in the Babati district in the Manyara region (Fig. 2) [20,21]. This area records a temperature of approximately 18 °C–33 °C with alternating seasons (dry, long, and short) of 400–500 mm rainfall annually at an elevation of 1,000 m from the sea level. The types of plants that dominated the area include edaphic grasslands, riverine vegetation, and Acacia woodlands. There are mainly two ethnic groups that are dominant around the Burunge WMA: Mbugwe which are agro-pastoralists and Maasai, which are pastoralists [22].

2.3. Individuals (households) recruited for data collection

This study adopted a cross-sectional design, whereby data were collected from the participants at a specific point in time. Apart from being relatively quick and inexpensive to conduct, a cross-sectional design is useful in establishing preliminary evidence that can be used to plan future advanced studies. The sample population used in this study was selected from three villages around Burunge WMA. Under the consent and guidance of local government authorities, the number of respondents from each study area was determined by considering the population size of the village as documented by Ref. [23] (Table 1).
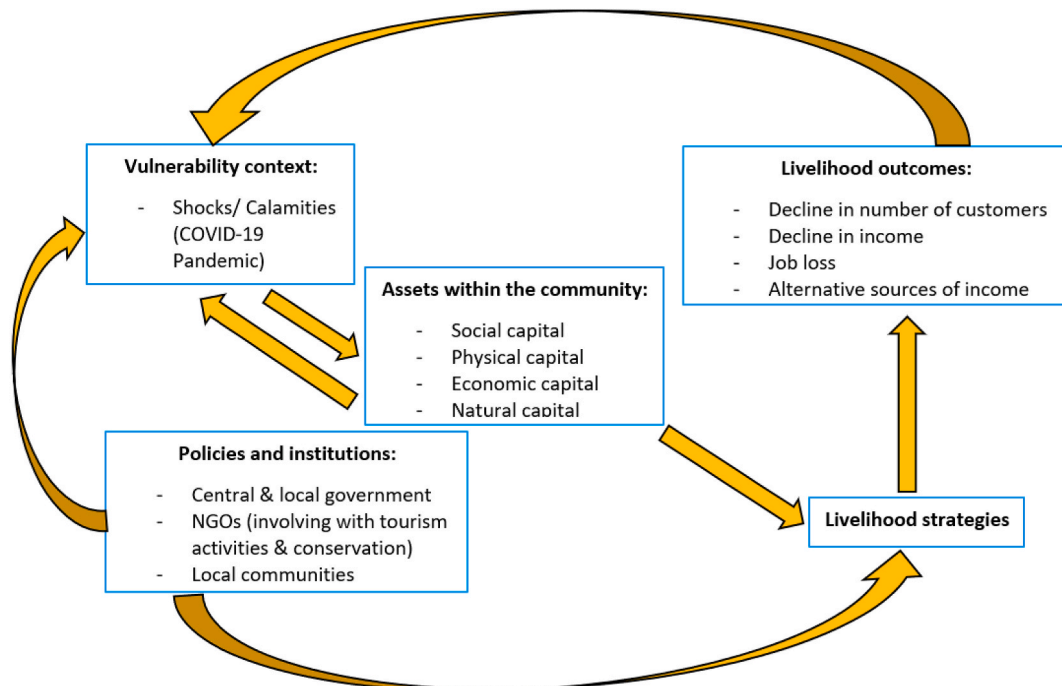

Fig. 1. The conceptual framework based on the sustainable livelihood approach (SLA). (Modified from Ref. [19]).
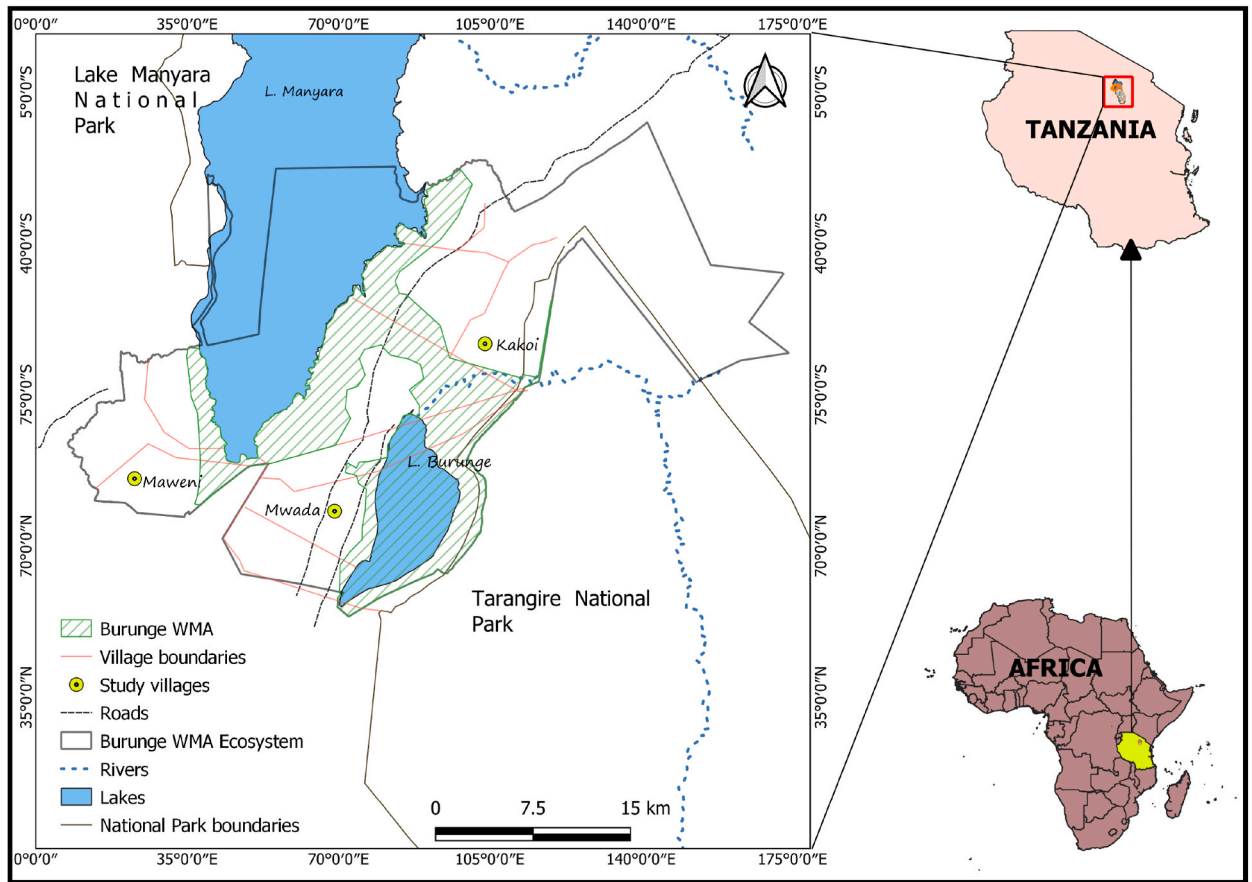
Fig. 2. A map of Burunge WMA located in the Tarangire-Manyara Ecosystem
(Created by authors using QGIS 3.24.1 Tisler).

A total sample size of 264 households was selected from three villages (Kakoi = 79, Maweni = 68, and Mwada = 117). The sample size used was at least 5 % of the entire population projected for this study, as suggested by Ref. [24]. The respondents were selected from each study village, and a list of villagers was provided by local government leaders in each village. Each member in a list was numbered, and random selection was performed using the random function from the excel sheet " = RAND " to obtain the individual (household) to be recruited for the interview. Semi-structured questionnaires were used to collect data from the selected respondents. Respondents were those aged 18 years and above, with the assumption that in this age category, a respondent will be involved in a particular socioe-conomic activity to earn income.

Furthermore, focus group discussions (FGDs) were also held in the study villages to get detailed information about the issues under study. As suggested by Ref. [25], FGDs should neither contain a large number of the discussants, as it will be difficult to manage a group during discussion, nor too small to fail to capture the large coverage of required information. Five FGDs were held intensively, with each group having at least six and not more than eight discussants, as recommended by Ref. [26]. During the formation of FGDs in each study village, the participation of an individual in any socio-economic activity that has been impacted by the COVID-19 pandemic was used as a criterion to be included in the discussion. The questions asked in the FGDs were those provided in the questionnaire, although flexibility was allowed to ensure that more information was captured from the respondents. In addition, comprehensive information on this study was gathered from key informants (KIs). The recruited KIs included 3 Burunge WMA leaders, 2 local government leaders, 3 conservationists in the Tarangire Manyara Ecosystem and 2 rangers. The information gathered from the semi-structured question-naires, FGDs, and KIs were about socio-economic status during the COVID-19 pandemic, alternative sources of income during the

Table 1
Population size and number of households from the study villages.

Study village(s)	Male	Female	Population size	Households
Maweni	1957	1684	3641	796
Kakoi	1900	1791	3691	613
Mwada	1951	1812	3763	808

COVID-19 pandemic, the status of the tourism sector and conservation during COVID-19, and any report regarding the impact of COVID-19 on biodiversity (mostly for KIs). In addition, an extensive literature review was conducted to explore the anticipated impact of COVID-19 on biodiversity conservation and income from the tourism sector.

Before conducting the study, the respondents were asked to fill out an informed consent form. The respondents were also guaranteed the privacy and confidentiality of their information. Moreover, they were told that participation in this study is purely voluntary and anyone is free to withdraw from it at any time during the process.

2.4. Socio-economic status during the COVID-19 pandemic

For each respondent, a semi-structured questionnaire was provided to collect data on the socio-economic activities they engaged in. Socio-economic activities that are environmentally and economically friendly are significant in the conservation of biodiversity, and any negative shift of local communities to other activities as a result of the COVID-19 pandemic is anticipated to cause problems in these areas. The socio-economic activities practiced by the respondents were collected from each village. Using the questionnaire, the effects of COVID-19 on the socio-economic practices of the respondents were obtained from each respondent. To increase the scope of the explored issue, FGDs were also held, with each group having at least five respondents.

2.5. Alternative sources of income during the COVID-19 pandemic

From the semi-structured questionnaires provided to the respondents, FGDs and KIs, information on the alternative sources of income adapted by the local communities as a means of survival during the COVID-19 pandemic was acquired. The alternative sources of income were those activities that the local communities decided to practice or intensify; specifically, those whose former sources of income were disrupted by COVID-19. The alternative sources of income considered here include: agriculture, fishing, livestock keeping, boda-boda (motorcycle taxis), restaurants, and other micro enterprises.

2.6. The status of tourism sector and conservation during COVID-19

More information was sought from respondents and KIs to better understand the status of COVID-19 in the WMA management area. Respondents were asked if the number of tourists in the study area was increasing, decreasing, or stable, particularly during the COVID-19 crisis. The classification for rating the number of tourists observed was very low (1–9 tourists observed per week), low (10–29 tourists observed per week), high (30–49 tourists observed per week), and very high (50 and above tourists observed per week). The respondents were asked to rate the number of tourists observed during COVID-19 and pre-COVID-19. In this case, the time for COVID-19 was March–May 2020, when the disease was declared and many countries practiced the so-called lockdown, while pre-COVID-19 was March–May 2019, when people were free and there was no declared COVID-19 and lockdown.

2.7. Implication and impact of COVID-19 on biodiversity conservation (ecological impact)

An extensive review of both online and printed information was done [27,28]. During the search for the required documents, language was not a barrier or restriction. Some of the key words, as shown in Table 2 below, were used to enable the acquaintance of relevant literature for this study on both the internet and printed documents. To obtain the targeted studies for review, search engines including Google scholar (https://scholar.google.com/), BASE (https://www.base-search.net/) and ResearchGate (https://www.researchgate.net) were employed, while a manual search was conducted to search the information from printed documents, including proceedings, official government reports, posters and other publications that were not available on the internet during the review. The explored and required information in the reviewed literature was about biodiversity conservation, human biodiversity interaction and the anticipated ecological impact of COVID-19 on the conservation of biological diversity.

2.8. Income status during the years (2019–2021) of COVID-19 outbreak in burunge WMA

The data on income generated by Burunge WMA were collected from secondary data, specifically the report kept by the WMA

Table 2
Identification, screening and eligibility of the documents included during literature review.

Identification (Record from)	Screening	Eligibility	Keywords used for searching
Google scholar (n = 45) Research gate (n = 24) Bielefeld Academic Search Engine (n = 11) Manual search (n = 5)	Screened documents (n = 85) 53 Included – full texts 32 Excluded – had only titles/abstracts related to the subject	39 full texts included, 14 excluded – had no required ecological information, detailed conservation issues, socio-economic status of local communities in relation to the outbreak of COVID-19 pandemic	COVID-19, Protected Areas Wildlife Management Areas (WMAs), Local communities adjacent protected areas, Alternative sources of income

management from 2006 to 2021. The data included the total revenue collected each year. The purpose of collecting this information was to understand the trend of revue collection and point out the effect of COVID-19 on revenue or income collection by WMA management. The time of COVID-19 in this trend was 2019/2020 and 2020/2021. The sources of income in Burunge WMA include fines, hunting and photographic tourism, with the tourism sector contributing 99 % of the total collected revenue.

2.9. Data analysis

Microsoft Excel® (Microsoft Corporation, Washington, USA) was used to record, classify, and organize the collected data. The analysis was performed using SYSTAT (Version 13.2 Inc. 2017) (http://www.systat.com) at a significance level of 0.05. A non-parametric statistical test (Kruskal-Wallis statistical test) was used to test the variation of variables such as, the information obtained on the socio-economic activities of the respondents, the number of tourists before and during COVID-19 on tourists, and the alternative sources of income adapted by the local communities adjacent to the Burunge WMA during the COVID-19 pandemic as a means of survival. Other descriptive statistics including, percentage and cross-tabulation were also used. In addition, graphs, tables, and charts were included to present a large amount of data in a detailed and simple manner.

Moreover, qualitative data were analyzed by using thematic analysis techniques. This method is usually used to analyze the content obtained from verbal or visual communication, documentary review and observations [29]. In the case of this study, the data obtained through FGDs and KIIs were analyzed using a thematic analysis method. The thematic analysis method provides the systematic ways of making valid inferences from data collected using visual, verbal or written means for the purpose of describing and quantifying the phenomenon under the study [30].The thematic analysis involves four main steps, namely: (i) the decontextualization, (ii) the recontextualization, (iii) the categorization and (iv) the compilation [31].

The decontextualization involved becoming familiar with the data by reading the transcribed text to get a sense of it. After getting the needed insights, the transcribed text was then broken down into smaller meaningful units which were then labeled with specific codes for easy understanding of the concepts. During the analysis, a coding framework was designed based on the questions used in KIIs and FGDs. It also included any important issue that was raised during the discussion with the respondents (Table 3). In that case, the main themes that were agreed upon by the researchers to best represent the responses of the discussants were: (i) socio-economic activities versus the COVID-19 pandemic (ii) alternative sources of income during the pandemic, and (iii) the status of tourism and conservation activities during the COVID-19 pandemic (Table 3). In the recontextualization phase, the original text was re-read in comparison with the final meaningful units to check whether all aspects of the content had been covered and marked with respect to the aim of the study. Moreover, to reduce the number of words, the extended meaningful units were condensed without losing the initial required content. In the categorization phase, themes and categories were identified. As suggested by Ref. [32], the researchers made sure that the identified categories and themes were internally homogeneous and externally heterogeneous. The last phase was the compilation process. It was at this phase that the researchers drew realistic conclusions about the findings and presented the meaningful data in the form of quotes.

3. Results

3.1. Socio-demographic profile of respondents

A total of 264 respondents from the three study areas were considered for participation in the study, of which 79, 68, and 117 respondents were selected from Kakoi, Maweni, and Mwada villages, respectively. There were 140 male respondents (53 %), and 124 female respondents (47 %) in the survey. Kakoi village had a large percentage of male participants compared to other villages whereas the number of female participants was higher in Maweni village. The variation observed in gender distribution among the three study villages was not significant (Kruskal-Wallis, H = 3.872, P = 0.144). In the case of age groups, the youth group dominated the population followed by the adult group. Maweni village had a large percentage of youths, followed by Mwada and then Kakoi. The percentage of the old group among other age groups was smallest across the three study villages. The variation in age groups across the three study villages was significant (Kruskal-Wallis, H = 17.118, P < 0.01). In addition to the collected information, the education level of respondents was also recorded, whereby a large number of respondents had primary education, followed by secondary education. The Kruskal-Wallis test showed that the distribution of education levels across the study villages was not significant (H = 5.967, P = 0.051) (Table 4).

Table 3
Themes (sub-themes) and coding framework used in thematic analysis.

Themes	Sub-themes	Codes
Socio-economic activities versus the COVID-19 pandemic	-Awareness of the impact of COVID-19 -Fluctuation in the number of customers and income generated during the COVID-19 pandemic	-Decline in income; job loss; decline in the number of customers
Alternative livelihoods	-Alternative sources of income adopted during the COVID-19 phase	-Any new or intensified activity during COVID-19 (i.e., farming, livestock keeping, boda-boda (motorcycle taxi, etc.)
Conservation and tourism status during the COVID-19 pandemic	- Fluctuation in the number of tourists arriving in the Tarangire Manyara Ecosystem -Anticipated impact of COVID-19 on conservation	-Income generated before and during COVID-19 in WMA; inconsistence in the number of tourists; cutting some operation costs

3.2. Socio-economic characteristics of the respondents

The respondents were involved in several socio-economic activities including fishing (4.2 %, n = 11), agriculture (28 %, n = 74), livestock keeping (17.8 %, n = 47), handcrafting activities (10.6 %, n = 28), micro enterprises (22.3 %, n = 59), and hunting (0.4 %, n = 1) while others were employed in various sectors including the industrial and education sector (16.7 %, n = 44). The difference across the three villages on the dominant socio-economic activities was noticed whereby; at Kakoi village, the dominant socio-economic activity was agriculture (25.3 %, n = 20), followed by livestock keeping (22.8 %, n = 18), micro enterprises (21.5 %, n = 17), employed (12.7 %, n = 10), fishing (6.3 %, n = 5), and handcrafting activities (11.4 %, n = 9) whereas 19.1 % (n = 13), 1.5 % (n = 1), 13.2 % (n = 9), 25 % (n = 17), 26.5 % (n = 18), 13.2 (n = 9), and 1.5 % (n = 1) were for agriculture, fishing, handcrafting activities, livestock keeping, micro enterprises, employed and hunting respectively in Maweni village while Mwada village had 35 % (n = 41) for agriculture, 4.3 % (n = 5) for fishing, 8.5 % (n = 10) for handcrafting activities, 10.3 % (n = 12) for livestock keeping, 20.5 % (n = 24) for micro enterprises and 21.4 % (n = 25) for employed. The variation observed in socio-economic activities across the three study villages was significant (Kruskal-Wallis, H = 8.765, P = 0.012) (Fig. 3).

3.3. Socio-economic activities versus COVID-19 pandemic

The impact of the COVID-19 pandemic was experienced by a large number of respondents in the three study sites, with 90.5 % (n = 239) of all respondents agreeing that COVID-19 had an impact on their livelihoods, while only 9.5 % (n = 25) claimed COVID-19 had no impact on their livelihoods. The impacts caused by the COVID-19 pandemic were mainly; deflation which leads to low income (91.7 %, n = 242), losing jobs (5.7 %, n = 15), and decline in the number of customers (91.7 %, n = 242), each one was calculated out of the total number of respondents. The percentage of respondents who lost their jobs due to COVID-19 was higher in Mwada village than in other villages. Majority of respondents reported a decline in income, of which Maweni village had the highest proportion, while Mwada village had the lowest representation with no significant variation across the three study villages (Kruskal-Wallis, H = 3.182, P = 0.204) (Table 5).

3.4. Alternative sources of income during the COVID-19 pandemic

The alternative sources of income adapted by the local communities adjacent to the Burunge WMA during the COVID-19 pandemic include fishing (9.5 %, n = 25), shops (5.7 %, n = 15), boda-boda (Motorcycle taxis) (3.4 %, n = 9), agriculture (22.3 %, n = 59), livestock keeping (27.3 %, n = 72), vendors (0.4 %, n = 1) and restaurants (2.3 %, n = 6) whereas 22.3 % (n = 59) had no alternative sources of income. Different people adapted different alternative sources of income in their respective areas, however, agriculture and livestock keeping were the dominant alternative livelihood across the study areas (Table 6). Mwada village has experienced a large percentage of individuals with no alternative sources of income as compared to other villages. The variation in alternative sources of income during the COVID-19 pandemic across the three study villages was significant (Kruskal-Wallis, H = 7.898, P = 0.019) (Table 6).

3.5. The status of tourism sector and conservation during COVID-19

The number of tourists flowing in the country particularly in the Burunge WMA declined sharply during the COVID-19 pandemic compared to a few years back. According to their observations, 96.2 % (n = 254) respondents argued that the number of tourists before COVID-19 was high, whereas 3 % (n = 8) and 0.8 % (n = 2) were for those who said the number of tourists was very high and others didn't know respectively, with the variation being not significant across the three study areas (Kruskal-Wallis, H = 0.156, P = 0.925) (Table 7). In the same regard, 94.3 % (n = 249) of respondents agreed that the number of tourists observed during the COVID-19 pandemic crisis was low compared to some months back, while 4.5 % (n = 12) were for the respondents who said the number of tourists was very low and 1.1 % (n = 3) for those who didn't know. The variation in responses across the three study villages was not significant (Kruskal-Wallis, H = 0.089, P = 0.956) (Table 7).

Table 4
Socio-demographic characteristics of the respondents in the three study areas (Kakoi, Maweni and Mwada).

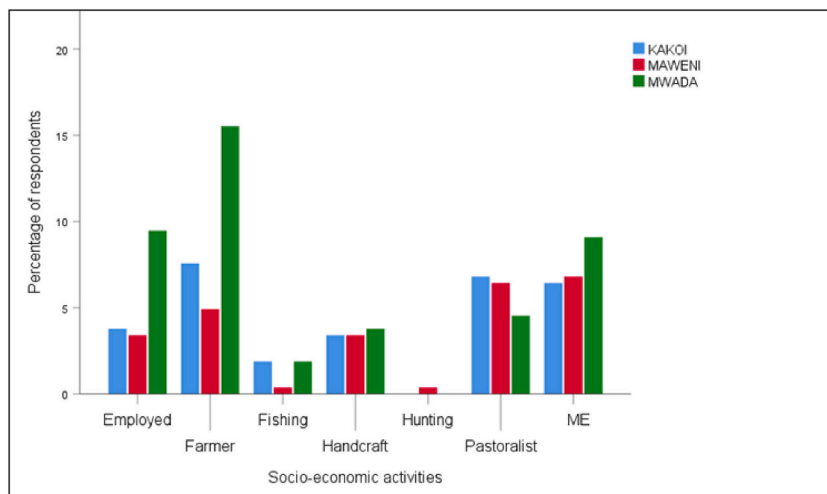| S/n	Variable	Categories	Kakoi % (n = 79)	Maweni % (n = 68)	Mwada % (n = 117)	Test statistic	P
1	Gender	Female	38 (30)	48.5 (33)	52.1 (61)	3.872	0.144
		Male	62 (49)	51.5 (35)	47.9 (56)		
2	Age	18-40 (Youth)	64.6 (51)	91.2 (62)	83.8 (98)	17.118	<0.01
		41-60 (Adult)	32.9 (26)	5.9 (4)	14.5 (17)		
		>60 (Old)	2.5 (2)	2.9 (2)	1.7 (2)		
3	Education level	Informal	5.1 (4)	5.9 (4)	4.3 (5)		0.051
		Primary	57 (45)	35.3 (24)	41.9 (49)		
		Secondary	30.4 (24)	57.4 (39)	36.8 (43)		
		Tertiary	7.6 (6)	1.5 (1)	17.1 (20)		

Fig. 3. Socio-economic activities of respondents in the three study areas (Kakoi, Maweni, and Mwada) Note: ME - Micro enterprises.

Table 5
Impact of COVID-19 on socio-economic activities across the three study villages (Kakoi, Maweni and Mwada).

Variable	Response	Kakoi % (n = 79)	Maweni % (n = 68)	Mwada % (n = 117)	Test statistic	P
Decline in number of customers	NO	6.3 (5)	2.9 (2)	12.8 (15)	6.065	0.048
	YES	93.7 (74)	97.1 (66)	87.2 (102)		
Decline in income	NO	6.3 (5)	2.9 (2)	12.8 (15)	6.065	0.048
	YES	93.7 (74)	97.1 (66)	87.2 (102)		
Losing jobs	NO	93.7 (74)	98.5 (67)	92.3 (108)	3.182	0.204
	YES	6.3 (5)	1.5 (1)	7.7 (9)		

Table 6
The alternative sources of income adapted by respondents during COVID-19 across the Three study villages (Kakoi, Maweni and Mwada).

Variable	Kakoi % (n = 79)	Maweni % (n = 68)	Mwada % (n = 117)	Test statistic	P
Fishing	17.7 (14)	8.8 (6)	4.3 (5)	7.898	0.019
Agriculture	20.3 (16)	11.8 (8)	29.9 (35)		
Boda-boda (Motorcycle taxis)	0	1.5 (1)	6.8 (8)		
Livestock keeping	20.3 (16)	39.7 (27)	24.8 (29)		
Handcrafting	11.4 (9)	4.4 (3)	5.1 (6)		
Shops	5.1 (4)	10.3 (7)	3.4 (4)		
Restaurants	1.3 (1)	5.9 (4)	0.9 (1)		
Vendors	0	1.5 (1)	0		
No alternative	24.1 (19)	16.2 (11)	24.8 (29)		

Table 7
The responses from respondents from three study villages (Kakoi, Maweni, and Mwada) in the variation of the number of tourists as observed in their areas near Burunge WMA.

Variable	Response	Kakoi % (n = 79)	Maweni % (n = 68)	Mwada % (n = 117)	Test statistic	P
Number of tourists before COVID-19	Very high	1.3 (1)	4.4 (3)	3.4 (4)	0.156	0.925
	High	97.5 (77)	95.6 (65)	95.7 (112)		
	Low	0	0	0		
	Very low	0	0	0		
	Don't know	1.3 (1)	0	0.9 (1)		
Number of tourists during COVID-19	Very high	0	0	0	0.089	0.956
	High	0	0	0		
	Low	94.9 (75)	94.1 (64)	94 (110)		
	Very low	2.5 (2)	5.9 (4)	5.1 (6)		
	Don't know	2.5 (2)	0	0.9 (1)		

3.6. Income status during the years (2019–2021) of COVID-19 outbreak in burunge WMA

From 2006/2007 to 2020/2021, the total amount of 10,773,236,671.06 TZS (4,299,654.78 USD) was collected by the Burunge WMA. Of this, the least amount of income of about 37,496,988.00 TZS (14,965.24 USD) was collected in 2006/2007, while the highest amount of 2,071,861,968.00 TZS (826,890.89 USD) was collected in 2017/2018. There was a significant increase in revenue throughout until 2012/2013 when a drop of up to 275,428,061.96 TZS (109,924.77 USD) from 473,738,859.93 TZS (189,071.64 USD) was recorded. After that, the situation recovered until the years 2019/2020 and 2020/2021 during COVID-19, where revenue collected declined to 476,740,689.00 TZS (190,269.69 USD) from the maximum collected amount of about 2,018,880,629.67 TZS (805,745.76 USD) in 2018/2019 before COVID-19 (Fig. 4). The rate of revenue declines due to COVID 19 from 2019/2020 to 2020/2021 was 32.5 % and 76.4 %, respectively, as compared to the year 2018/2019. This was similarly expressed by one of the KI who asserted that:

> "During COVID-19, we were collecting ten times lower income as compared to normally collected revenue … …. To rescue the situation, we decided to cut the operation cost by 60% and focus on sensitive issues only …. For instance, the budget for oil/ diesel for patrolling inside and around the WMA was reduced from 3,000,000 TZS (USD 1,302.93) to less than 1,000,000 TZS (USD 434.31)".

3.7. The anticipated impact of COVID-19 on biodiversity conservation (ecological impact)

The evidence from the reviewed literature shows that the effects of the COVID-19 pandemic on biological diversity conservation can be directly or indirectly caused by several factors and seen in different ways and perspectives (Fig. 5). Some of the effects caused by the COVID-19 pandemic include habitat destruction and conversion, an increase in human-wildlife conflict, and the transmission of zoonotic diseases due to an increase in human, wildlife, and livestock interaction (Table 8). During this study, crop cultivation, livestock keeping, disruption of socio-economic activities due to minimal tourists' visitation and massive fishing activities were reported to increase in the study villages out of other aspects, as shown in Fig. 5. Other cases were reported in other literature to happen in different protected areas, including those in the Tarangire -Manyara Ecosystem (Fig. 5).

4. Discussion

4.1. Socio-demographic profile of respondents

In this study, the percentage of male respondents was 6 % higher than that of female respondents. The marginal difference observed was because men are, in most African cultures, the heads of families and engage in any matter involving decision-making, inputs, or any other contribution [39]. The findings showed that the dominant age group among the respondents was the youth group as compared to the other groups. It was observed that a large number of individuals in this age group were more involved in different socio-economic activities than the others. At the age of 18–40, a person becomes energetic and capable of performing several duties efficiently under minimal supervision. This age group has been referred to as more active and productive in society because of its
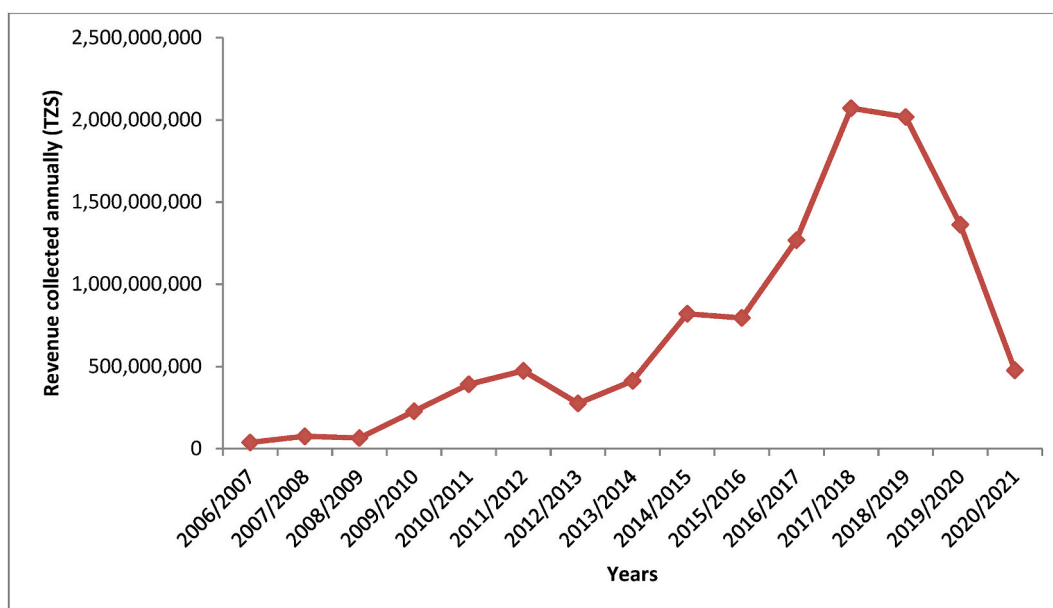

Fig. 4. Burunge WMA' revenue collection trend over several years before (2006–2018) and during COVID-19 pandemic (2019–2021).

Fig. 5. Direct and indirect effects of COVID-19 as related to the local communities' livelihoods and biodiversity conservation (a close linkage between). Note: LULCC – Land use land cover change, CBNRM – Community based natural resource management, CBC – Community based conservation.

Table 8
The anticipated negative influence of COVID-19 on the biodiversity conservation within and around the Burunge WMA.

Driver of changes (During COVID-19)	Outcomes (Actions)	Impact on biodiversity conservation (Ecological impact)	References
Major alternative sources of income as adapted by local communities adjacent the Burunge WMA	-Intensive agriculture within and around the PAs	-Habitat conversion, loss & degradation -Unfavorable LULCC within and around the PAs -Accelerate human-wildlife conflicts -Land isolation and patches	[13,33–36]
	-Increased livestock keeping (large herds of livestock)	-Habitat conversion, loss & degradation -Transmission of zoonotic diseases -Soil erosion & degradation	[34,35,37]
	-Intensive fishing activities (Illegal fishing methods e.g., poisoning)	-Over-fishing -Disruption of ecological processes in water ecosystem -Eruption of food chain in the water habitats	[34,36,38]
Collapse of some local businesses including	-Decline in number of customers -Reduced sales -Job loss	-Increased poaching activities -Illegal tree cutting (deforestation & timber logging) -Encroachment in protected area (Burunge WMA)	[10,12,36]
Minimal visitation of tourists in the Burunge WMA	-Loss of revenues	-Instability of community-based conservation -Failure to implement different development projects in the participating villages -Tour guides lost their jobs -Provision of environmental education to the local communities stopped -Reduced numbers of patrols	[10,12,13, 36]

Note: WMA-Wildlife Management Area, PAs - Protected Areas, LULCC – Land use land cover change.

contribution to various activities for the welfare of their own families as well as the local communities [40]. According to Ref. [41], the complexity of environmental problems can be mitigated by re-channeling education to the youth group on the importance and use-fulness of nature to stimulate sustainable development in both conservation issues and local communities' livelihoods. In addition, Ref. [42] argued that youth are innovative, continually growing, problem-solving-oriented, passionate, and knowledgeable; thus, investing in them would have a huge positive impact on the conservation of biodiversity and the improvement of livelihoods in so-cieties. The majority of respondents had a primary education level followed by a secondary education level, as it is in most families of farmers and pastoralists in many African countries and Tanzania in particular. The findings in this study suggest the need and importance of educating and empowering youth groups for the benefit of society as well as the conservation of wildlife and natural resources, as they are the main custodians of the protected areas, in agreement with other studies [41,42].

4.2. Socio-economic characteristics of the respondents

The findings from the study revealed that the majority of the surveyed residents adjacent to the Burunge WMA were undertaking different types of activities; however, farming, fishing, and cattle keeping were the predominant means of generating income. The socio-economic activities varied slightly from one village to another. For example, most of the individuals in Mwada village were farmers, while those in Kakoi and Maweni were engaged in both livestock husbandry and farming practices. The variation in socio-economic activities encountered between the three areas of study was possibly influenced by multiple factors, such as the propor-tion of a certain age category over another, the availability and accessibility of land for agricultural purposes and pastures, as well as the proximity of a specific area to the protected area. This is in agreement with earlier studies conducted in villages surrounding protected and conserved areas in many places, particularly Tanzania. For instance, a study by Ref. [43] in the Esilalei, Barabarani, and Migombani villages within the Tarangire-Manyara ecosystem indicated that the primary socio-economic activities in these locations are subsistence farming, cattle husbandry, and other tourism-based activities. Moreover, research conducted in villages near Saadani NP (SANAPA) indicated that many indigenous and local societies located near protected and conserved areas depend largely on agricultural practices and livestock keeping and that the observed variation among such villages was influenced by the size of the local people's landholdings and the geographical location of the specific villages to the parklands [44–46]. In addition to that [47], found that most areas inhabited by Maasai people, including rural villages in Simanjiro, which are found in the Tarangire-Manyara Ecosystem, and Amboseli, were interested in crop cultivation compared to other socio-economic activities.

4.3. Socio-economic activities versus COVID-19 pandemic

The three study villages faced the misery of the COVID-19 pandemic in their socio-economic activities. The study reveals that the local communities located adjacent to the protected areas encountered several issues, including a decrease in the number of customers and deflation, leading to reduced income in nearly the same range throughout the study villages. It was further noticed that in Mwada village, the percentage of individuals who had lost their jobs due to the COVID-19 pandemic was greater in comparison to the other surveyed places. The reason underlying this was the dependence of local communities on the tourism industry and other WMA-linked activities. Similar results have been reported in other countries worldwide. For example, research performed in five selected WMAs indicated that nearly all the tour operators at Ikona WMA lost their jobs as a result of the COVID-19 pandemic, whereas the same has been noticed in Enduimet, Randiren and Makao WMA, where some workers, particularly those paid by the local communities, were given leave without receiving their wages, while others were working on loans [10]. Further results in Malawi have shown that a huge number of local communities involved with agriculture, beekeeping, and fishing suffered significantly as a result of the COVID-19 outbreak. The decline in the number of visitors in protected areas in Malawi due to the COVID-19 pandemic, who were the main buyers of honey and other commodities, resulted in a downturn in sales in the market, thus significantly affecting their lives [48].

4.4. Alternative sources of income during the COVID-19 pandemic

As a mechanism for survival during the COVID-19 juncture, community members had to discover new means of earning income for their livelihoods. However, due to the disproportional sharing of conservation costs and poor application of participatory approaches, the problem of depending entirely on a single source of income that may jeopardize the existence of protected areas prevails [49–51]. In Kakoi, Maweni, and Mwada villages, people shifted to other alternative approaches for their lives, including farming, livestock husbandry, and fishing, while others engaged in boda-boda (motorcycle taxis), restaurants, and other micro-enterprises. Others had no alternative sources of earning income; the scenario described by Ref. [52] caused people to break several regulations and rules to sustain their livelihoods. The study found that the abovementioned activities captured the attention of many because they were the only available ways of generating income for the indigenous and local people adjacent the protected areas during the COVID-19 pandemic. In addition, the aforementioned activities were among the most familiar socio-economic tasks performed by many local communities, and thus most had prior experience on how to operate and run them accordingly. The findings revealed that the re-percussions caused by COVID-19 on income and sales in markets led to the minimal collection of personal revenues; hence, they were not capable of providing all the basic requirements for their families. Uncontrolled livestock keeping and intensive farming, among other activities, have been termed more dangerous for the existence of natural habitats and wildlife species [34]. The massive flow of people from different places into the local villages as a means to ensure their safety during the COVID-19 pandemic is likely to increase pressure on land use and natural resource exploitation, thereby threatening natural habitats and wildlife growth [25]. For instance, it was observed that a large number of people moved from urban areas to rural areas, especially those working in the informal economy,

to search for alternative means of livelihood. The urban-rural movement of the people tends to increase the population size while the resources are limited; as a result, other residents may engage in illegal activities, including poaching and deforestation, to earn their living. As supported by Ref. [53], an unplanned increase in the number of people around the protected areas threatens the safety of biodiversity and the biosphere reserve as a whole. The close linkage between the diversification of sources of earning income and illegal conduct inside or around protected and conserved areas may induce unfavorable land use land cover change, thus leading to the destruction of wildlife species and natural habitats [54,55].

4.5. The status of tourism sector and conservation during COVID-19

The findings in this study show that the number of tourists visiting Tanzania declined massively, as identified by the respondents, with little variation between their responses. It was noticed that the number of tourists registered within a week fell from about 300 visitors before the COVID-19 outbreak to at most 9 visitors during this pandemic. These findings are in agreement with the results obtained by Ref. [56], which put an estimate of a 20–30 % fall in tourist arrivals worldwide in 2020 compared to 2019 as a result of the COVID-19 pandemic. In addition, the findings of the survey conducted by Ref. [57] revealed a sharp decrease in booking requests from potential customers from different countries across the globe. For instance, there was a decline of more than 75 % (>75 %) (184 operators/68.7 % of all operators) in requests for new bookings as a result of the COVID-19 outbreak, whereas there was an increase of more than 75 % (>75 %) in cancellations of existing bookings (134 operators/50.0 % of all operators) [57]. The 90 % dependence of many WMAs in Tanzania on tourism activities, mainly photographic and hunting tourism [10], has deteriorated the conservation issues and other operations of these protected areas in a very destructive way. As such, there is a need to have diversified means of collecting revenue rather than relying entirely on tourism.

4.6. Income status during the years (2019–2021) of COVID-19 outbreak in burunge WMA

It was clear from the findings that the revenue decline halted potential operations in the Burunge WMA. The reported fall in collected income forced the management to minimize necessary expenditures and focus much more on very sensitive operations, such as combating poaching through patrols, although the challenges were still there. For instance, the budget for oil and diesel for patrolling inside and around the WMA was reduced from 3,000,000 TZS (USD 1,302.93) to 1,000,000 TZS (USD 434.31). Burunge WMA depends greatly on photography and hunting tourism for its revenue. Therefore, the massive decline in the number of tourists due to COVID-19 dragged them into a messy ending. These findings correspond with those reported by Refs. [56,58], where a loss of approximately USD 300–450 billion was estimated due to the decline in the number of tourist arrivals worldwide. Moreover, the study conducted by Refs. [13,59] shows that the same situation and fall-down were also experienced by other countries, including Indonesia, the United States of America, and Canada.

4.7. The anticipated impact of COVID-19 on biodiversity conservation (ecological impact)

Apart from having a direct impact on protected and conserved areas, including WMAs, the COVID-19 pandemic has also indirectly influenced the likelihood of threatening the survival of several species and the existence and sustainability of their natural habitats. The disturbance and disruption of various socio-economic activities, especially tourist-dependent local businesses, including hand-crafting activities, conducted by the local communities adjacent to the protected area (i.e., Burunge WMA), has caused some negative repercussions. A large number of indigenous and local people turned to other activities, including intensive agriculture and livestock keeping, which, when conducted inappropriately, become dangerous for the survival of wildlife and their natural habitats [13,34,36]. Moreover, as highlighted in this study's findings, the sharp and intense decline in the number of tourists in many protected areas worldwide, and Tanzania in particular, exacerbated the difficulties in management and the achievement of planned and targeted goals in many ways. The massive loss of revenue as a result of the COVID-19 pandemic led to the failure of several managerial issues and developmental projects not just within the protected area but also in the participating local communities, in agreement with other studies, including those conducted by Refs. [10,12]. The COVID-19 pandemic has been reported to have nothing to do with the issue of poaching and other illegal activities in the Tarangire-Manyara ecosystem, contrary to what has been found by other studies [36,38,59] in various places around the world where poaching, deforestation, and other illegal activities are reported to increase during this juncture. The reason behind the minimal cases of poaching and other illegal issues may probably be an intensive and total focus, as well as a shift of most WMA's workers on patrols and protection of wildlife and WMA's boundaries during the COVID-19 pandemic, as reported by some leaders from the Burunge WMA Authority. The occurrence of COVID-19 has opened many wildlife sector authorities' and adjacent local communities' eyes to how prepared these sides should always be to minimize the effects of unanticipated disasters like COVID-19.

4.8. Implication in biodiversity conservation

COVID-19 has revealed the resilience level of the most protected and conserved areas in Tanzania and worldwide. The COVID-19 outbreak has led to severe consequences for both protected areas and the local population, which relies on various activities taking place alongside these areas. The study found that some individuals were employed in the tourism sector, while others were involved in different informal socio-economic activities within and around the WMA to make a living. The interruption of the tourism sector has thus caused considerable difficulties in dealing with various circumstances in protected areas and neighboring local people, who face

numerous animal conservation challenges, particularly by delegating their plots of land for conservation and enduring several cases caused by wildlife in their communities. The findings of the study revealed that the shift of local communities to alternative forms of revenue signified the start of a new episode in wildlife protection, particularly after discovering that agriculture, fishing, and livestock keeping, among other things, were the most popular alternative means of income adopted by communities during the COVID-19 juncture. By examining the effects of these activities on natural ecosystems and the diversity of species [34], there is a need to develop a range of methodologies and tactics to mitigate their overall impact on biodiversity. There is a very close link between local communities' livelihoods and protected areas (Fig. 5). Once their sources of income get disrupted, the likelihood of invading and over-exploiting available resources increases, which is dangerous for wildlife and future generations. According to Ref. [60], there is a need for the local community to have a diverse source of income that is both socially and environmentally friendly rather than relying only on tourists to avoid potential biodiversity damage.

5. Conclusion and recommendation

Among other sectors, the wildlife industry was also affected by COVID-19, with some operations inside protected areas and among participating communities being halted. The consequences of the COVID-19 pandemic were felt not only in the protected and conserved areas but also in the local communities surrounding these areas. Unreadiness to act immediately and effectively during the COVID-19 pandemic worsened the socio-economic status of the indigenous and local communities due to the lack of diversified sources of income. For the sake of their lives, many individuals who had their previously sources of income disrupted by the pandemic, decided to either shift to or intensify agricultural activities, cattle rearing, and fishing as a survival strategy. Due to a lack of alternative sources of revenue, many individuals may become involved in illegal activities, such as poaching and deforestation, which risk the sustainability of protected and conserved areas.

To mitigate the significant negative repercussions of unanticipated crises such as COVID-19 on local communities and biodiversity, it is proposed to encourage and assist indigenous and local people with diverse sources of income that are environmentally and economically friendly, including fish farming and beekeeping, to lessen their total reliance on natural resources. Moreover, the protected and conserved areas authorities should encourage and promote local tourism to minimize the entire dependency on foreign tourists.

We would like to recommend similar studies to be carried on other WMAs as our study focused only on Burunge WMA which could be different from others. In addition to that, there is a need to conduct a study to explore the differences in income collected during the pandemic and the level of repercussions among all WMAs in Tanzania. This move will help to both give a general picture of the situation between the WMAs and set the baseline for preventing the impact of future unanticipated disturbances. Moreover, this study has specifically adopted the SLA design; therefore, there is still room for other studies to be carried out and adopt other livelihood framework models.

Ethical declaration

The University of Dodoma provided ethical clearance for this work, with reference number MA.84/261/02.

Informed consent

Informed consent was obtained from individual participant included in the study.

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Francis Chebby: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Naza Mmbaga:** Writing – review & editing, Writing – original draft, Supervision, Methodology. **Kelvin Ngongolo:** Writing – review & editing, Writing – original draft, Supervision, Methodology.

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.

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References

[1] D. Neupane, How conservation will be impacted in the COVID-19 pandemic, Wildl. Biol. 2020 (2) (2020), https://doi.org/10.2981/wlb.00727.

[2] D. Pinner, M. Rogers, H. Samandari, Addressing Climate Change in a Post-Pandemic World, McKinsey Q., 2020, pp. 1–6 [Online]. Available: https://www.mckinsey.com/~/media/McKinsey/Business Functions/Sustainability/Our Insights/Addressing climate change in a post pandemic world/Addressing-climate-change-in-a-post-pandemic-world-v3.ashx.

[3] S. Saadat, D. Rawtani, C.M. Hussain, Environmental perspective of COVID-19, Sci. Total Environ. 728 (2020) 138870, https://doi.org/10.1016/j.scitotenv.2020.138870.

[4] UNDP, Socia-economic Impact of Covid-19 on the People of Uganda, 2020.

[5] World Bank, "COVID-19 (Coronavirus) Drives Sub-Saharan Africa Toward First Recession in 25 Years," Www.Worldbank.Org.

[6] N.J. Bennett, et al., The COVID-19 pandemic, small-Scale fisheries and coastal fishing communities, Coast. Manag. 48 (4) (2020) 336–347, https://doi.org/10.1080/08920753.2020.1766937.

[7] M. Rulli, Experts in Kenya fear poaching, deforestation are surging during COVID-19 lockdown, Accessed: Sep. 28, 2021. [Online]. Available: https://abcnews.go.com/International/experts-kenya-fear-poaching-deforestation-surging-lockdown/story?id=70500218.

[8] E. Nyomi, A reflection on world environment day: is there really A silver lining for nature amidst this pandemic?, Accessed: Sep. 27, 2021. [Online]. Available: https://www.wabicc.org/a-reflection-on-world-environment-day-is-there-really-a-silver-lining-for-nature-amidst-this-pandemic/.

[9] African Union Commission, Impact of the corona virus (covid 19) on the african economy, J. Chem. Inf. Model. 53 (9) (2020) 1689–1699.

[10] R.A. Shoo, E. Mtui, J. Kimaro, N. Kinabo, G. Lendii, J. Kideghesho, Wildlife management areas in Tanzania: vulnerability and survival amidst COVID-19, in: Managing Wildlife in a Changing World [Working Title], 2021, https://doi.org/10.5772/intechopen.97396.

[11] M. of, Natural Resources and Tourism, "The Wildlife Policy of Tanzania.", Government Printer Dar es Salaam, Tanzania, 1998.

[12] J.R. Kideghesho, H.S. Kimaro, G. Mayengo, A.W. Kisingo, Will Tanzania's wildlife sector survive the COVID-19 pandemic? Trop. Conserv. Sci. 14 (2021) https://doi.org/10.1177/19400829211012682.

[13] A. Spenceley, et al., "Tourism in protected and conserved areas amid the covid-19 pandemic,", Parks 27 (2021) https://doi.org/10.2305/IUCN.CH.2021.PARKS-27-SIAS.en.

[14] R. Manenti, et al., The good, the bad and the ugly of COVID-19 lockdown effects on wildlife conservation: insights from the first European locked down country, Biol. Conserv. 249 (2020), https://doi.org/10.1016/j.biocon.2020.108728.

[15] V.P. Sati, L. Vangchhia, A Sustainable Livelihood Approach to Poverty Reduction: an Empirical Analysis of Mizoram, the Eastern Extension of the Himalaya, Springer, 2016.

[16] A. Quandt, Measuring livelihood resilience: the household livelihood resilience approach (HLRA), World Dev. 107 (2018), https://doi.org/10.1016/j.worlddev.2018.02.024.

[17] I.G.K. Ansah, C. Gardebroek, R. Ihle, Resilience and household food security: a review of concepts, methodological approaches and empirical evidence, Food Secur. 11 (6) (2019), https://doi.org/10.1007/s12571-019-00968-1.

[18] J.N. Gichure, S.K. Njeru, P.M. Mathi, Sustainable livelihood approach for assessing the impacts of slaughterhouses on livelihood strategies among pastoralists in Kenya, Pastoralism 10 (no. 1) (2020), https://doi.org/10.1186/s13570-020-00184-z.

[19] O. Serrat, Knowledge Solutions: the Sustainable Livelihoods Approach, Knowledge Solutions, 2017.

[20] C. Kiffner, et al., Community-based wildlife management area supports similar mammal species richness and densities compared to a national park, Ecol. Evol. 10 (1) (2020), https://doi.org/10.1002/ece3.5916.

[21] WWF, "Tanzania ' s Wildlife Management Areas, A 2012 Status Report, 2014, pp. 1–70.

[22] A. Kaswamila, An analysis of the contribution of community wildlife management areas on livelihood in Tanzania, Sustainable Natural Resources Management (2012), https://doi.org/10.5772/32987.

[23] Nbs, "Tanzania Population and Housing Census 2012,", Natl. Bur. Stat. Minist. Financ. Dar es Salaam, 2013.

[24] NIST, "Selecting Sample Sizes. Engineering Statistic Handbook," NIST an agency of the U.S. Department of Commerce.

[25] F. Chebby, N. Mmbaga, K. Ngongolo, Land use land cover change and socio-economic activities in the Burunge Wildlife Management Area ecosystem during COVID-19, Heliyon 9 (3) (2023), https://doi.org/10.1016/j.heliyon.2023.e14064.

[26] W. Boateng, Evaluating the efficacy of focus group discussion (FGD) in qualitative social research, Int. J. Bus. Soc. Sci. 3 (7) (2012).

[27] K. Khan, R. Kunz, J. Kleijnen, G. Antes, RESEARCH METHODOLOGY Five steps to conducting a systematic review, J. R. Soc. Med. 96 (3) (2003) 118–121.

[28] M.S. McDonagh, et al., Systematic review of water fluoridation, BMJ 321 (7265) (2000) 855–859, https://doi.org/10.1136/bmj.321.7265.855.

[29] C. Kothari, Research Methodology: Methods and Techniques, second ed., 2004, https://doi.org/10.1192/bjp.111.479.1009-a.

[30] B. Downe-Wamboldt, Content analysis: method, applications, and issues, Health Care Women Int. 13 (3) (1992) 313–321.

[31] M. Bengtsson, How to plan and perform a qualitative study using content analysis, NursingPlus Open 2 (2016), https://doi.org/10.1016/j.npls.2016.01.001.

[32] K. Krippendorff, Content Analysis: an Introduction to its Methodology, Sage publications, 2018.

[33] N.E. Mmbaga, L.K. Munishi, A.C. Treydte, How dynamics and drivers of land use/land cover change impact elephant conservation and agricultural livelihood development in Rombo, Tanzania, J. Land Use Sci. 12 (2017), https://doi.org/10.1080/1747423X.2017.1313324, 2–3.

[34] H.A. Seki, D.D. Shirima, C.J. Courtney Mustaphi, R. Marchant, P.K.T. Munishi, The impact of land use and land cover change on biodiversity within and adjacent to Kibasira Swamp in Kilombero Valley, Tanzania, Afr. J. Ecol. 56 (3) (2018) 518–527, https://doi.org/10.1111/aje.12488.

[35] A. Sigala, K. Ngongolo, N. Mmbaga, Awareness and involvement of local communities adjacent Kihansi catchment in conservation of the re-introduced Kihansi spray toads (Nectophrynoides aspergins), Glob. Ecol. Conserv. 31 (October) (2021) e01861, https://doi.org/10.1016/j.gecco.2021.e01861.

[36] G. Walters, et al., COVID-19, indigenous peoples, local communities and natural resource governance, Parks 27 (2021), https://doi.org/10.2305/IUCN.CH.2021. PARKS-27-SIGW.en.

[37] K. Ngongolo, "Influence of Cattle Movement , Ecological and Risk Factors on Trypanosome Infections of Cattle in Simanjiro and Monduli Districts , Tanzania,", 2020.

[38] J. Waithaka, et al., Impacts of COVID-19 on protected and conserved areas: a global overview and regional perspectives, Parks 27 (no. Special Issue) (2021), https://doi.org/10.2305/IUCN.CH.2021. PARKS-27-SIJW.en.

[39] G. George, R. Kotha, P. Parikh, T. Alnuaimi, A.S. Bahaj, Social structure, reasonable gain, and entrepreneurship in Africa, Strateg. Manag. J. 37 (6) (2016) 1118–1131, https://doi.org/10.1002/smj.2381.

[40] United Urt, Republic of Tanzania, national population policy, Ministry of planning Economy and Empowerment 4 (3) (2006) 235–245.

[41] F. Morar, A. Peterlicean, The role and importance of educating youth regarding biodiversity conservation in protected natural areas, Procedia Econ. Financ. 3 (12) (2012) 1117–1121, https://doi.org/10.1016/s2212-5671(12)00283-3.

[42] T. Nadeson, M. Barton, The role of youth in the conservation of biodiversity: WWF-Malaysia's experiences, Population (Paris) 15 (40) (2014) 6–13.

[43] A. Kaswamila, Human-wildlife conflicts in monduli District, Tanzania, Int. J. Biodivers. Sci. Manag. 5 (4) (2009), https://doi.org/10.1080/17451590903557526.

[44] A.W. Komba, T. Watanabe, M. Kaneko, M.B. Chand, Monitoring of vegetation disturbance around protected areas in central Tanzania using landsat time-series data, Rem. Sens. 13 (9) (2021) 1–18, https://doi.org/10.3390/rs13091800.

[45] N.E. Mmbaga, L.K. Munishi, A.C. Treydte, Cropping patterns along an altitudinal gradient and their implications to wildlife conservation in Rombo, Tanzania, Glob. Ecol. Conserv. 28 (2021) e01683, https://doi.org/10.1016/j.gecco.2021.e01683.

[46] B.S. Moshi, Impacts of Protected Areas on Local Livelihood : a Case Study of, vol. 44, July, 2016.

[47] D.K. Nkedianye, et al., Comparative social demography, livelihood diversification and land tenure among the Maasai of Kenya and Tanzania, Pastoralism 10 (2020) 1–25.

[48] A.N. Attah, "Initial Assessment of the Impact of COVID-19 on Sustainable Forest Management African States," United Nations Forum for. Secr., No. April, 2021.

[49] F. Carius, H. Job, Community involvement and tourism revenue sharing as contributing factors to the UN sustainable development goals in jozani–chwaka bay national park and biosphere reserve, zanzibar, J. Sustain. Tour. 27 (6) (2019), https://doi.org/10.1080/09669582.2018.1560457.

[50] F.F. Kimario, N. Botha, A. Kisingo, H. Job, Theory and practice of conservancies: evidence from wildlife management areas in Tanzania, Erdkunde 74 (2) (2020), https://doi.org/10.3112/erdkunde.2020.02.03.

[51] K.K. Holland, et al., Impacts of tourism on support for conservation, local livelihoods, and community resilience around Maasai Mara National Reserve, Kenya, J. Sustain. Tour. 30 (11) (2022), https://doi.org/10.1080/09669582.2021.1932927.

[52] FAO, COVID-19 global economic recession, Avoiding Hunger Must Be at the Centre of the Economic Stimulus, 2020, https://doi.org/10.4060/ca8800en.

[53] N. Botha, H. Job, F. Kimario, Potential and challenges of the serengeti-ngorongoro biosphere reserve, Tanzania, Eco.mont 13 (2021), https://doi.org/10.1553/ECO.MONT-13-SIS27.

[54] M. Loibooki, H. Hofer, K.L.I. Campbell, M.L. East, Bushmeat hunting by communities adjacent to the Serengeti National Park, Tanzania: the importance of livestock ownership and alternative sources of protein and income, Environ. Conserv. 29 (3) (2002) 391–398, https://doi.org/10.1017/S0376892902000279.

[55] E.J. Knapp, Why poaching pays: a summary of risks and benefits illegal hunters face in Western Serengeti, Tanzania, Trop. Conserv. Sci. 5 (4) (2012) 434–445, https://doi.org/10.1177/194008291200500403.

[56] UNWTO, "International tourist arrivals could fall by 20-30% in 2020,", Unwto.Org 34 (2020) 33–34 [Online]. Available: https://www.unwto.org/news/international-tourism-arrivals-could-fall-in-2020.

[57] Safaribookings.com, The Impact of the Coronavi- Rus Pandemic on the Safari Industry, 2021 [Online]. Available: https://www.safaribookings.com/blog/coronavirus-outbreak.

[58] UNWTO, International Tourist Numbers Could Fall 60-80% in, 2020. https://en.travel2latam.com/nota/60051-international-tourist-numbers-could-fall-60-80-in-2020-according-unwto.

[59] M. Hockings, et al., Editorial essay: covid-19 and protected and conserved areas, Parks 26 (no. 1) (2020), https://doi.org/10.2305/IUCN.CH.2020.PARKS-26-1MH.

[60] F. Ellis, E. Allison, Livelihood Diversification and Natural Resource Access, LSP Work. Pap., no. January, 2004.