



“Wild birds are our gold”: What livelihood implications does it hold for local communities in Chemba district, Tanzania?

Enock Makupa^{a,*}, Theresia Philemon^a, Japhet Ringo^a, Anibariki Ngonyoka^b

^a Department of Geography and Environmental Studies, College of Social Sciences and Humanity, University of Dodoma, Tanzania

^b Department of Conservation Biology, School of Biological Sciences, University of Dodoma, Tanzania

ARTICLE INFO

Keywords:

Livelihoods
Wild birds
Quelea quelea
Hunting
Chemba district
Tanzania

ABSTRACT

Hunting wild birds for food, ornaments, and business purposes has been a longstanding practice in the Chemba district, and local communities consider the wild bird business as the "gold" that transforms their livelihoods. This article builds on a livelihood framework to document livelihoods gained from wild bird business across livelihood capitals at the household level. We conducted a 146-household survey, 16 interviews, 4 focus group discussions, and observations to gain field information that helped to develop the article. Results show that *Quelea quelea* species are the most targeted wild birds; however, other, non-targeted species were harvested in the study villages. There are significant livelihood contributions among wild bird hunters, processors, and sellers, with disproportionate benefits across the livelihood assets in the study area. The mean weekly income from selling live wild birds varies across the villages and ranges between USD 13.5 and 18.48. A significant difference is observed when comparing the income gained from selling roasted wild bird meat and selling live birds. The most commonly acquired physical assets are related to buying consumables to meet family needs, followed by buying livestock and bricks for the construction of houses. Those who engage in the wild bird business also diversify their livelihood strategies by engaging in farming and non-farming activities. We argue that, despite the different livelihoods gained from hunting and selling live or roasted wild birds' meat, the practice in the study area should be regulated to ensure that the health of wild bird consumers and the ecological functions of the targeted wild bird species are not compromised. The article provides socio-ecological information that is useful in designing sustainable methods for harvesting *Quelea quelea* while protecting other bird species in central Tanzania and elsewhere with similar experiences.

1. Introduction

Hunting of wild animals has been a major contributor to the short-term impact on human well-being in communities, with long-term consequences for biodiversity and ecosystem integrity. The source of food is one of the most significant short-term impacts on humans [1–3]. Moreover [4], finds that wild meat in rural Zimbabwe, Tanzania, and South Africa accounts for 15–58 % of households' cash income. Other studies elsewhere assert that the contributions of wild animals and birds to humanity, include rituals, ornaments, and environmental cleaners [5–7]. As for the long-term impacts on biodiversity, they encompass depopulation, habitat deterioration,

* Corresponding author.

E-mail address: emakupa@yahoo.co.uk (E. Makupa).

<https://doi.org/10.1016/j.heliyon.2023.e22452>

Received 3 May 2023; Received in revised form 11 November 2023; Accepted 13 November 2023

Available online 20 November 2023

2405-8440/© 2023 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

and extinction of some wildlife species [8–10].

In Africa, since time immemorial, hunting wildlife has been a conservation agenda, and this activity is still part of the routine of many traditional communities. Hunting has occurred in both protected and open areas for nutritional and cultural reasons [5,11,12]. Despite the fact that hunting of wild birds has been around since the very earliest periods of human history, the current evidence demonstrates the increase of this activity [7,12]. The reasons for this scenario involve an increase in the human population, the dramatic advancement of hunting technology, and less enforcement of regulations for natural resource management [13–15].

In Tanzania, the hunting of wild birds is increasing in line with the expansion of crop cultivation to new areas that previously provided natural food and habitat for wild birds [16,17]. Meanwhile, most wild birds are considered pests in agriculture because of crop raiding. It is estimated that in years of heavy rains, about 2.7 million tons of cereal crops worth Tshs. 198.7 billion, equal to US\$ 2.4 million, are lost annually due to the crop damage associated with the problem of wild birds [16]. In Dodoma for example, it is estimated that approximately \$60,000 was lost due to grain losses caused by *Quelea quelea*, which subsequently necessitated the importation of about 5080 tons of grains as relief food [17]. Literature shows effort to control *Quelea quelea* birds in the Chemba district started six decades ago. It involved arial spraying and allowing the community to hunt wild birds for food and income as an alternative way to reduce and recoup losses caused by wild birds [18,19]. In recent years, the local communities have increased the harvest of the *Quelea quelea* for food and income gains as the human population increases, demands for wild birds have been escalating.

So far, studies on wild birds in Chemba District have focused on the influence of seasons on the illegal harvest of wild birds [19] and factors affecting the attitudes of local people toward the red-billed *Quelea quelea* [18]. These studies give little consideration to the implications of wild birds' business on the livelihoods of people at the household level. For instance [19], study shows the contribution of harvested wild birds to the people's income but does not show how the income gained from hunting and selling roasted wild bird meat impacts positively or negatively the livelihood of the people (i.e hunters processors and sellers) who engage directly in the wild bird business at the household level. However, the effects of hunting and selling roasted wild bird meat on people's livelihoods at the household level remain a grey area worth investigating. This paper therefore aimed at providing an understanding of livelihoods gained across the livelihood capitals that are associated with the hunting and selling of wild bird meats among the local household members who engage directly in the wild bird business in the Chemba district. It is important to assess income gained from the wild birds business as one of the livelihood strategies that contribute directly to the well-being and quality of life of people at the household level [20]. This is due to the fact that the survival of many African rural people depends on the extent of diversification of the individual or household income to raise their life standards [21]. argues that livelihood diversification (LD) is essential for fostering economic development and eradicating rural poverty. Also, diversifying rural sources of income aims to protect rural peoples from environmental and economic shocks [22,23]. Livelihood diversification refers to a process by which household members construct a diverse portfolio of activities and social support capabilities in their struggle for survival and to improve their standards of living [24].

In this case, local communities in the Chemba district engage in the wild birds business as a way of diversifying their livelihood options. Thus, any development intervention that may cause the destruction of the ecological base of wild birds, might affect the livelihood options of the local community positively or negatively. Studies on livelihoods at the local level are well documented, for instance Ref. [25], noted that in the communities surrounding gas extraction plants in Tanzania, their socio-economic base is highly vulnerable due to the gas extraction caused by declining agricultural and fish catches, thus negatively affecting their livelihoods. Similarly [26], uses a Sustainable Livelihood Framework to analyse rural livelihoods strategy in rural Zimbabwe and observed that the dependency on agriculture as the main source of livelihood in rural is decreasing, while the non-agricultural sector is experiencing significant growth that increases the source of rural employment and diversification of rural livelihoods. In Cambodia [27], adopted SLF to assess the impact of the REDD + project on local livelihood assets and show a significant increase in overall capital assets. Such livelihood analysis and studies enable an understanding of how the lives of local communities operate, the changes occurring across their livelihood capitals, and their implications on their livelihoods.

1.1. Theoretical framework

The concept of livelihood emerges in understanding the progress of human beings in response to the question of whether people's lives become better or worse at family and community levels [28]. It refers to how individuals or communities secure their basic needs and sustain their well-being [20]. It involves various activities, resources, and strategies that people employ to earn a living and support themselves and their families. The livelihood is influenced by a range of factors including socio-economic conditions, political structures, cultural norms, environmental changes, and technological advancement [29]. Understanding livelihood is important for policymakers and development practitioners as it helps to identify opportunities for poverty reduction and sustainable development in the rural community setup.

The livelihood approaches provides guidance and broadens understanding of the study by echoing [20] livelihood definition. Livelihood "comprises the capabilities, assets, and activities required for a means of living". Whereby "a sustainable livelihood must cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the next generation." Consequently, it must contribute net benefits to other livelihoods at the local and global levels and in the short and long term [29]. Thus, it presents good principles of development that reflected on assets building (financial, natural, social, human, physical); livelihoods (that comprise of assets, capabilities, and activities necessary for means of living); reducing exposure to the vulnerability conditions and sustainability enhancement [30] features that allow broader understanding of the various aspects that influence and shape rural livelihoods.

The sustainable livelihood framework (SLF) is a tool for development that highlights how to understand, analyse, and describe the main factors that affect people's livelihoods [31]. It provides the analytical basis for the assets endowment of the rural poor in the form

of the livelihood platform of the five assets or capitals, i.e., natural, financial, physical, human, and social capitals [20]. Natural capital it refers to natural resources endowments of a particular area such as water, land, forests, biodiversity, air, minerals, oil and gas, etc. They are useful for livelihoods and are of special importance for poor people who depend on natural resource-based activities to derive all or part of their livelihoods [32]. Financial Capital is defined as all the financial resources and availability of cash or equivalent that people use to achieve the objectives of their livelihoods. It enables people to adopt various livelihood strategies, and are of two sources including accessible stocks that consist of cash, bank deposits, or liquid assets (that can easily be converted into cash), and regular inflows of money that comprise labour income, transfers from the state, pensions, and remittances. Financial capital is the most versatile, as it can be easily converted into other types of capital or it can be used to achieve livelihood outcomes directly [30]. Physical capital consists of producer goods and the basic infrastructure needed for supporting livelihoods. Examples of such physical capital include the availability of transport, adequate water supply and sanitation, secure houses and buildings, clean and affordable energy, and availability of information infrastructures. Poor infrastructure can prevent education, income generation, and access to health services which in turn affect the livelihood of the people [32]. Social capital means the social resources through which people get to seek their livelihood outcomes, for example, networking and connectedness that increase people’s trust and ability to cooperate. It also includes any form of association of more formal groups and their systems of rules, norms, and sanctions. Access to social capital and its amount is determined through factors such as birth, age, gender, faith, work, or ideology of the people which normally build bonds from one individual to another. Social capital can also cause effects that restrict their livelihood strategies and development [30]. According to the SLF, human capital is defined as the skills, knowledge, ability to labour, and good health that together enable people to pursue different livelihood strategies and achieve their livelihood objectives [33]. At the household level, human capital varies according to the household size, skill levels, leadership potential, health status, etc. Any changes in human capital may affect individual livelihood status and access to other livelihood assets.

In other words, the SLF emphasizes that different kinds of assets or capital that exist in a particular society, when combined, help people achieve the livelihoods they pursue. SLF provides a holistic understanding of various dimensions that influence people’s ability to secure their livelihoods sustainably. It also acknowledges the importance of managing natural resources in a way that ensures their availability for future generations and recognises unsustainable practices can lead to resource depletion and undermine the livelihood security of the local people [34,35]. In this article, seasonality and environmental shocks directly affect all five components of the livelihood assets linked with the hunting and selling of wild birds. Further, the assets influence laws and regulations governed by wildlife-related public and private structures. However, the same structures, laws, and policies affect access to both livelihood assets and livelihood outcomes, as indicated in Fig. 1.

An assessment of the livelihood outcome of hunting wild birds for local communities considers a comprehensive range of factors within the livelihood framework that drives hunting [35,36]. In this study, we use livelihood capitals/assets in relation to the livelihoods of hunters, processors, and sellers of wild birds in the Chemba district. The framework helped to track and build an understanding of the livelihood outcomes of people who engaged in hunting and selling wild birds live or roasted birds’ meat using a lens of five livelihood capitals. In this article, items such as social networks, relations of trust, and mutual understanding and support associated with the wild bird business were addressed as *social capital*. Social capital is relevant as it facilitates collective actions, cooperation and mutual support among the households that are involved in the wild birds business. It as well helps them to access resources, share knowledge and information regarding marketing, availability, and seasonality of wild birds [37]. Items such as income gained associated with the wild bird business (credit and debt) are considered *financial capital*, which was assessed to gain a

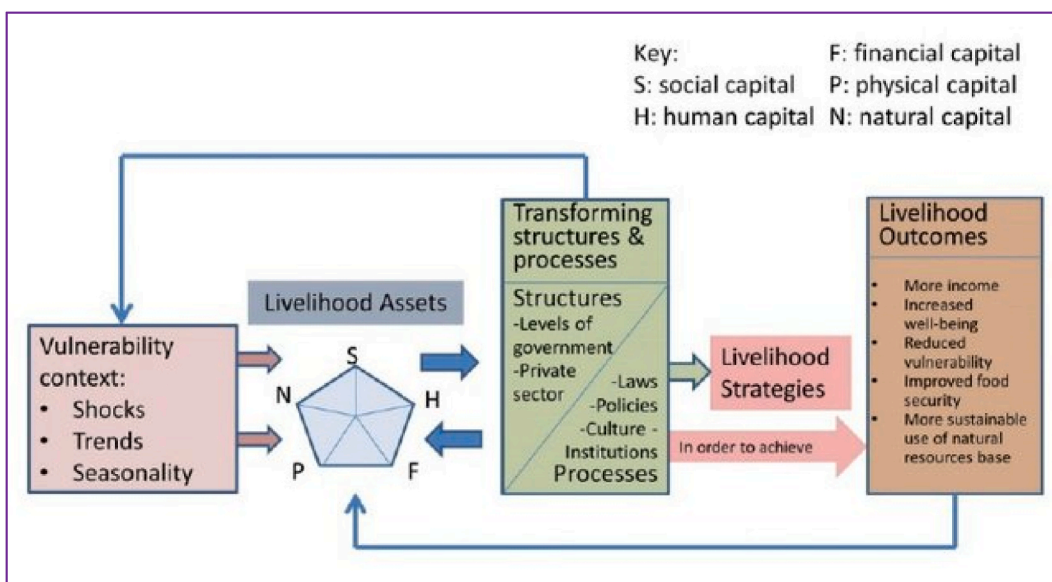


Fig. 1. Sustainable livelihood framework by DFID [24].

better understanding of how that impacts the livelihoods of the wild bird hunters, processors, and sellers in the study area. Financial capital is crucial as it enables individuals who engage in the wild birds business to cope with shocks and risks and improve their overall economic well-being [38]. Items such as the hunter’s skills, knowledge, wild bird trapping techniques, and the ability to labour were considered human *capital*. This helped to unpack and document the evolution of wild bird trapping techniques over time in the study area. Human capital is vital to enhance productivity, adaptability and resilience in rural livelihoods. It enables those who engage in wild birds business to diversify economic activities, make informed decisions and respond effectively to changing circumstances over time [39]. Items such as bicycles, bricks, iron sheets, land ownership, power tillers, and small kiosks were considered *physical capital*. This helped to build an understanding of the livelihood assets gained related to the wild bird business. Physical capital is essential for enabling wild bird business including hunting, processing and selling of roasted wild bird meat. It facilitates access, infrastructure to market and information related to wild birds business [37,40]. Items such as live and roasted wild bird meat (protein), swamps, bushes, and farmlands were considered *natural capitals* that facilitate local community interaction with nature. Understanding the availability, quality and sustainability of wild birds is crucial for assessing the potential for sustainable livelihoods in the study area [29].

2. Material and methods

2.1. The study area

Chemba district is located at latitude -5.3377° south and longitude 35.6914° east. The total area covers 925,000 ha, where, about one-quarter of which is used for farming and the remaining is covered by the Swagaswaga Game Reserve. The study covered four selected villages in the district, including Kilema Balai, Mondo, Cheku B, and Kelema Maziwani (Fig. 2). These villages form a part of the wild birds’ migratory corridor, especially the *Quelea quelea* bird species, and the area is characterized by seasonal river streams and some wetlands. The community around engages mainly in agriculture activities, cultivating finger millet, sunflower, maize, pearl millet, finger millet, and cassava for subsistence and commercial purposes. The nature of the crops cultivated, the presence of wetlands sites, and river streams are features that attract migratory wild birds to reside in the area for easy food access and breeding sites. The migratory and resident wild birds in the area create a threat to agricultural crop production as they destroy food crops before harvest season. Due to that, the community members consider wild birds to be problem birds. Hunting and killing of wild birds is the main

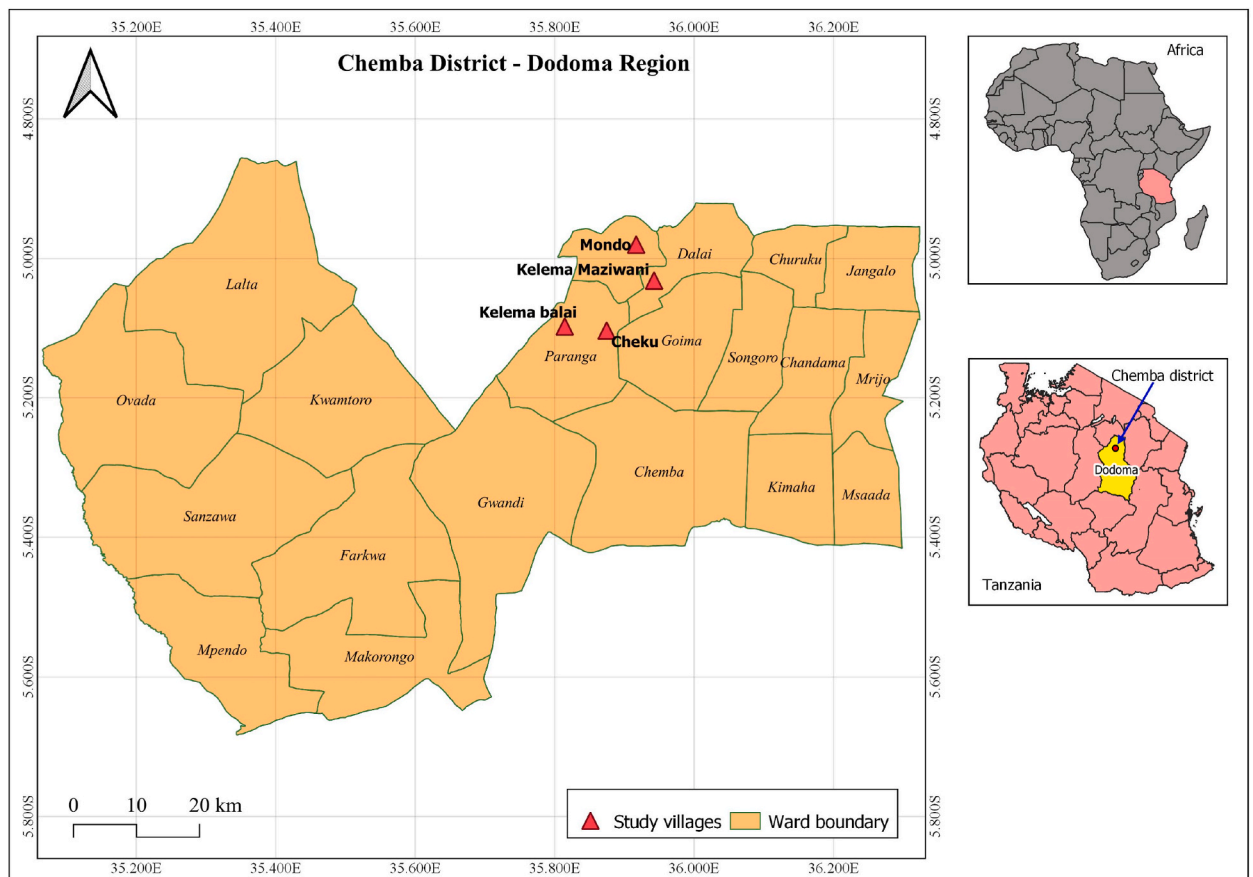


Fig. 2. Map showing study villages in Chemba District, Dodoma.

mitigation measure the community has adopted to address the challenge caused by wild birds. At the same time, the mitigation measure adopted has created an opportunity for community members involved in hunting and killing wild birds to gain income from a growing market for alive and roasted wild bird meat. It is against this background that the study opted to assess the contribution of wild birds in improving individual livelihoods at the household level.

2.2. Data collection

The study adopted a cross-sectional design where a combination of methods were used for triangulating information obtained from the field. Initially, before data collection, a pilot study was conducted to establish contacts, familiarize with the study area, and gather key information that helped to shape the study's research tools. The methods involved interviews, focus group discussions, observation, and a survey of heads of households that engage in buying and selling alive or roasted wild birds' meat. Open-ended interviews were conducted with 16 key informants, who were selected based on their job position in the villages or the district. This involved 4 village leaders, 1 district natural resource officer, 3 wild bird hunters, 2 wild bird transporters, 2 wild bird processors, influential people (1 religion and 1 political leader), and 2 popular wild bird sellers in the study area. A pre-meeting or contact with key informants was made for interview arrangements before the date of the interview. Interviews with key informants were conducted in different places depending on the availability of the respondents. Thus, some interviews were conducted in the participants' offices, some were conducted under the tree outside the participant's house, and a few were conducted in the respondent's small kiosk business centre. The key informants provided detailed insights into how wild birds are hunted and how the roasted wild bird business shapes the livelihood of the individuals in the study area.

A total of four Focus Group Discussions (FGDs) were conducted in four study villages. Three FGDs were conducted with community members who are hunters and experts at setting wild bird traps in the field. One FGD involved women who engage in the preparation of hunted wild birds before meeting the market. The groups were composed of 5–10 members each. Group participants were identified with assistance from village leaders based on pre-defined criteria, including individual engagement in hunting and killing of wild birds, age (18 years and above), and education level (at least completed primary education and above). Group discussions were conducted in Swahili, a native and national language spoken and understood by the majority in Tanzania, and took an average of 1–2 h per session. Information from FGDs was recorded by using an electronic recorder and by taking notes of the key issues raised during group discussions. The group discussions were critical to soliciting the different views and opinions of the wild bird hunters and those who engage directly in the wild bird business regarding their opinion about the contribution of the wild bird business to their livelihood at the household level.

Further, a survey with heads of households that engage directly in the wild bird business was conducted. Initially, before conducting the household survey in each study village, the village leader assisted in identifying a popular wild bird hunter in the village. Then a snowball was used to generate a list of household heads who engage in buying and selling hunted and killed wild birds based on the hunters' experience and recommendations. This was an important approach, as it was expected that the livelihood benefits attributed to hunting and killing wild birds could be realized more by the people who engage directly in the wild bird business compared to other community members. A total of 146 heads of household were identified across the four study villages, including 52 from Kilema Balai, 42 from Cheku B, 36 from Kelema Maziwani, and 16 from Mondo village. A questionnaire research tool with open and closed questions was applied to gather information from all 146 identified heads of households, where the researchers conducted a face-to-face survey with respondents, asking questions and simultaneously filling out the questionnaires. This method helped to capture information related to household assets associated with the wild bird business and build an understanding of other social and economic benefits that contribute to improving the livelihood of the people who engage in the wild bird business at the household level.

2.3. Data analysis

The quantitative data on demographic characteristics, household mean income and livelihood outcomes were cleaned, coded, and entered into the Statistical Package for Social Sciences (SPSS) version 26 program, which was used to analyse the data. The analysed data was later exported to R studio software version 4.0.3 (R core team 2020) to generate the bar graphs, charts, and tables presented in the article. Additionally, the comparison of mean household income among villages was tested at $P < 0.05$. The qualitative data collected with interviews and FGDs were analysed through content analysis (CA), which helped to categorize the collected data into various themes related to the study topic and presented in the form of quotations as findings or information to support discussion.

3. Results

3.1. Characteristics of respondents participating in Wild birds business

This research presents quantitative and qualitative findings about the species of most hunted wild birds and their livelihood contribution to local communities across villages and groups in the Chemba District. While all assets were linked to livelihood benefits in the wild bird business, analysis confirmed that the amount of harvested birds and livelihood opportunities varied across villages and groups. In terms of gender, results show wild bird hunting is dominated by males (75.3 %, $n = 110$) compared to females (24.7 %, $n = 36$), [Table 1](#). However, women were involved in the plucking of bird feathers, roasting, and packaging of hunted wild birds. The majority ranging from 78.6 % to 93.8 % of the respondents across the study villages had attained the primary level of education, which

is a common feature in many rural areas of Tanzania. The results show that, apart from the wild bird business, respondents identified other activities that diversify their livelihood strategies, with more than 80 % of respondents across the study villages indicating farming as a dominant livelihood activity in their area.

3.2. Wild birds species targeted by the local community

It was found that *Quelea quelea* was the main target for 100 % of the interviewed respondents, with varying consensus on the other non-targeted species. Prominently, Red-billed *Quelea quelea*, Cardinal *Quelea quelea*, and Red-headed *Quelea quelea* (all 100 %) were significantly harvested. However, in order of importance, other harvested species were pigeons (65.5 %) and spurfowl (6.8 %). Similarly, the frequency of responses across villages was consistent for the three above-mentioned species (Table 2). However, direct observations in field traps and processing revealed more non-targeted wild bird species, such as widow birds, bishop birds, red-cheeked-cordon blew and fire finches were captured.

3.3. Community livelihoods associated with harvesting of wild birds

Livelihood contribution in our study is limited to the outcome contribution of wild bird harvesting in terms of financial, social, natural, physical, and human capital.

3.3.1. Financial contribution

To establish the financial contribution associated with wild bird harvesting, we analysed the data from household members involved in wild bird harvesting. The findings indicate that 15.9 % (n = 146) of the total respondents were involved in the business. Interestingly, this study found that Kelema Balai village had the largest share of individuals involved in business than all other villages combined (Fig. 3).

Furthermore, the involvement of local communities in the harvesting of wild birds in surveyed areas is motivated by selling wild birds (28 %), for food purposes (63.8 %), and those involved in both food and business were 17.9 %. There was variation in the mean weekly income generated through selling alive wild birds across villages, ranging from Tanzania shillings 31,167.67 to 42,515.38 (Fig. 4). However, the variation in mean household income was not significant (F3, 61, DF = 0.05, P = 0.6672).

On the other hand, the mean household daily income for selling roasted birds among villages showed contrasting findings with selling alive birds, ranging from Tsh. 8500 (\$4) to Tsh. 35,190 (\$15). Kelema Balai had recorded a disproportionately high daily household income compared to other villages (Fig. 5).

Furthermore, there are temporal variations of price across actors in the market chain of the Chemba district, from hunters to consumers (Table 3).

In comparison with other activities, about 46 % of the respondents viewed wild business income as higher or equal to income gained from other livelihood activities (Fig. 6).

3.3.2. Physical assets from wild bird business

Twenty-six per cent of the respondents acquired tangible household assets from the business. In comparison to other assets, the most acquired physical assets are related to purchasing consumables to meet family needs, followed by purchasing livestock and bricks for house construction (Fig. 7).

3.3.3. Human capital contribution

The wild bird business contributed to the improvement of skills, knowledge, and the ability to labour. This study documents the evolution of trapping techniques from the 1970s to date. Initially, the hunters used snares on the nests, where catching success was around 5 birds. Trapping improved through the use of catapults in the early 1980s, then in the late 1980s, moved to the *gum snare*, 'ulimbo', with a catching success of 30 birds. Furthermore, trapping technology evolved through the use of holes ('matundu') in the

Table 1
Respondents' characteristics.

Variable		Villages			
		Kelema Balai	Cheku B	Mondo	Kelema maziwani
Sex	M	80.8 (n = 42)	76.2 (n = 32)	68.8 (n = 11)	69.4 (n = 25)
	F	19.2 (n = 10)	23.8 (10)	31.2 (n = 5)	30.6 (n = 11)
Education	Informal	7.7 (n = 4)	16.7 (n = 7)	0	2.8 (n = 1)
	Primary	88.5 (n = 46)	78.6 (n = 33)	93.8 (n = 15)	88.9 (n = 32)
	Secondary	3.8 (n = 2)	2.4 (n = 1)	0	8.3 (n = 3)
	University/college	0	2.4 (n = 1)	6.3 (n = 1)	0
Occupation	Farming	82.7 (n = 43)	97.6 (41)	93.3 (n = 15)	94.4 (n = 34)
	Livestock	17.3 (n = 9)	28.6 (n = 12)	37.5 (n = 6)	25 (n = 9)
	Wild birds business	17.3 (n = 9)	9.5 (n = 4)	12.5 (n = 2)	5.6 (n = 2)
	Small business kiosk	15.4 (n = 8)	2.4 (n = 1)	18.8 (n = 3)	8.3 (n = 3)

Table 2
Percentage of respondents consuming the harvested wild bird species.

Variable	Villages			
Species	Kelema Balai	Cheku B	Mondo	Kelema Maziwani
Quelea quelea	34.3 (n = 48)	29.3 (n = 41)	10.7 (n = 15)	25.7 (n = 36)
Pigeon	30.2 (n = 29)	28.1 (n = 27)	11.5 (n = 11)	30.2 (n = 29)
Spurfowl	50 (n = 5)	30 (n = 3)	0	20 (n = 2)

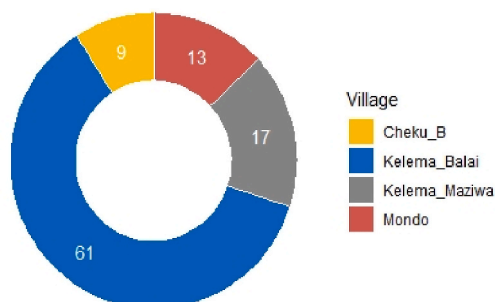


Fig. 3. The proportion of individuals involved in the business of wild birds.

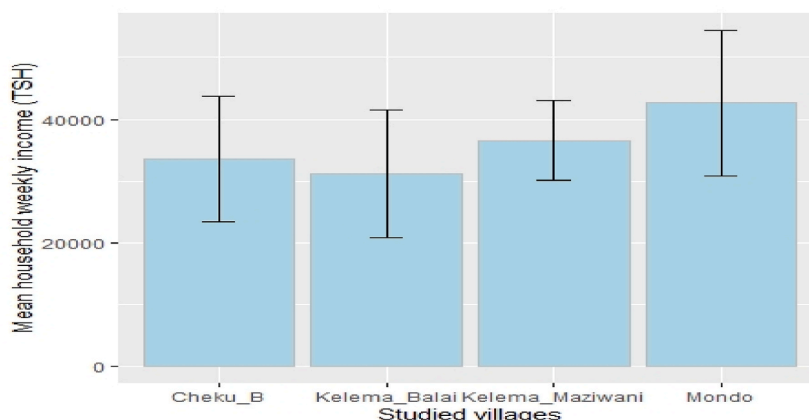


Fig. 4. Mean weekly household income accrued from selling alive birds.

1990s, with a catch success of 200–300 birds (Plate 1). Currently, the most innovative means of trapping birds is through the use of fishing nets, which improved the catch of 2000 birds (Plate 2).

3.3.4. Social capital contribution

Our findings have also portrayed that the wild bird harvesting business has helped those engaged in different ways. During interviews, one of the participants mentioned that the business helped him pay a dowry for marriage, as indicated in the statement below.

"... through this business (the wild bird business), I have managed to marry and pay dowry without assistance from my parents. Also, I have managed to open a small kiosk shop for my wife. The business has much profit, and someone with financial discipline can serve and do a lot to improve the lives"

The business has also created networking (social capital) between sellers and hunters at the local level and beyond. Wild bird sellers have managed to establish interaction with hunters across the villages where wild bird harvesting activities are conducted, while also creating a network with bird consumers beyond their marketing area. Meanwhile, it has enhanced the social trust and status in the community because those involved in the wild bird business processing and selling have their unique social trust and recognition compared to other community members who are not engaged in the business. They gain community trust that makes it easy for them to access loans from individuals or microfinance organizations, as demonstrated in the statement below from one of the respondents;

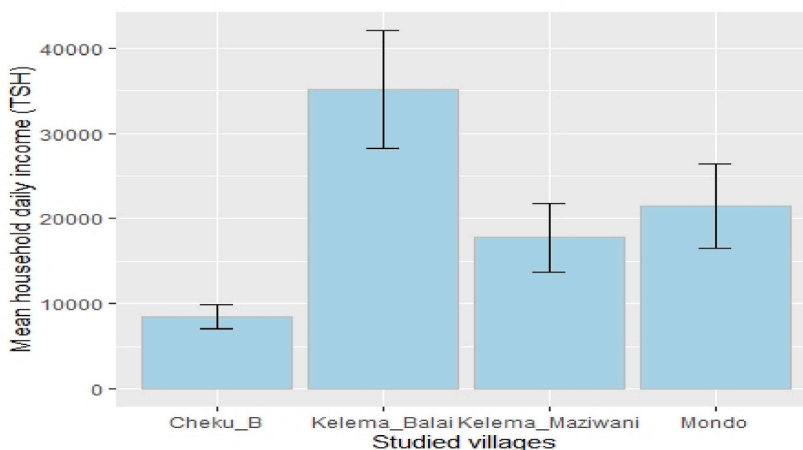


Fig. 5. Mean daily household income accrued from selling roasted birds.

Table 3

Price variation among actors of the marketing chain across months in the year.

Months	Hunter price	Agent price	Selling price
July to October	8 birds per Tsh. 1000	5-6 birds per Tsh. 1000	3 birds per Tsh.1000
February to June	12-15 birds Tsh. 1000	10 birds per Tsh. 1000	3 birds per 500 Tsh

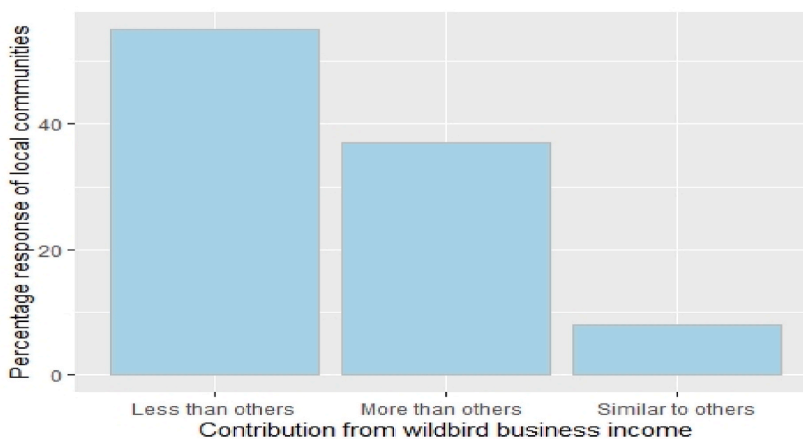


Fig. 6. Comparison between incomes accrued from wild bird business and other activities.

"...engaging in wild bird business allows me to gain some amount of money daily It has become even easier for me to access loans from friends or local microfinance (popularly known as "vikoba") because people trust me that I will be able to recover the loan without problem.."

3.3.5. Natural capital

The local communities consider wild bird meat a good source of food (protein). They perceived *Quelea quelea* as more delicacy and nutritious compared to other sources of animal proteins. It is also regarded as a cheap and affordable source of protein for many who cannot afford to purchase a kilogram of beef or chicken meat. This was clearly captured during a focus group discussion in Mondo Village, as indicated in the following statement;

"..If one has Tsh. 1000 (equivalent to USD 0.43), can buy five roasted wild birds, which are enough for a single-family meal, compared to 1 kg of beef, which is very costly, ... Instead, many prefer to buy roasted wild birds (at the time of this research, 1 kg of beef was Tshs. 6,000, equivalent to USD 2.6).."

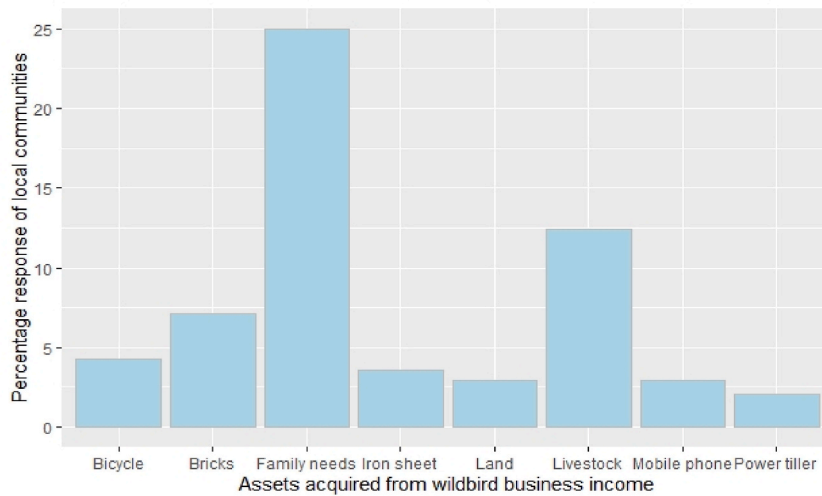


Fig. 7. Percentage of responses of local communities on assets acquired from wild birds business.



Plate 1. Tundu/Hole trap.



Plate 2. Net trap.

Additionally, men were found to prefer eating roasted wild bird meat more than women, as many believed the meat gave them natural energy and increased their sexual performance. The myth has increased demand for wild bird meat among the men in the study villages and beyond, which in turn has increased income for the people who engage in the wild bird business. One of the old men, 70

years old, an experienced wild bird hunter in Kelema Balai village, explained during the interview;

"Ooh! for my experience in wild bird hunting, I can tell you *Quelea quelea* meat is vital to men because once they get into sexual performance with their partners, the duration and speed of sexual performance match the speed of *Quelea quelea* when flying ... (laugh) ... I am eating roasted *Quelea quelea* meat daily, and I have two wives, and all of them are happy with my sexual performance(laugh) ... ".

4. Discussion

This research study shows how the livelihoods of the local communities in the Chemba district are intertwined with the hunting and selling of live and roasted wild birds. It has revealed the extent to which harvested wild birds are supporting the sustainable livelihood outcomes of the hunters, processors, sellers, and their households, as described in Fig. 1.

Although the study revealed that wild bird harvesting principally targeted *Quelea quelea*, it also shows that non-targeted species were included in the process. The reasons for the success of catching *Quelea queleas* are that they are regarded as pest birds by the government policy and by laws [41], have a higher abundance, and are simple to catch. Furthermore, non-targeted species of similar body size to *Quelea quelea*, such as Red Checked Cordon blew, Fire fitches, and Widow birds were processed for consumption. Trapping of non-targeted species may be caused by the non-selectivity of the traps, greed for profit maximization, and failure to distinguish morphometric features of the weavers related to *Quelea quelea*. Likewise, literature shows that the use of nets in trapping wild birds contributes to the catching of non-targeted species [13,42,43]. Similarly, the farmers in the study area were the primary actors in the business of hunting wild birds despite engaging in other farm activities. A similar condition was observed by Ref. [44] in the study related to livelihoods from the Lablab Value Chain in Tanzania.

As far as livelihood is concerned, this research depicts significant livelihood contributions among hunters, processors, and sellers, with disproportionate benefits in terms of income and assets gained associated with the wild bird business. Although Mondo and Kelema Maziwani villages had fewer individuals involved in the wild bird business (Fig. 3), they received a high mean weekly income for trading live birds (Fig. 4). Conversely, the same villages received the lowest mean daily income compared to Kelema Balai village in terms of selling roasted birds (Fig. 5). The higher weekly income accrued from selling live birds at Mondo and Kelema Maziwani is probably because they serve as hunting sites. Contrariwise, Kelema Balai actors accrue the most in terms of daily income for the roasted birds because they act as the trading centre for collecting, processing, and selling wild birds.

While other studies [19] showed the income generated through selling birds per person is about Tsh. 3 million (\$1293) annually, this study presents new evidence of much higher income derived from the same business. In addition [19], argued for the seasonal accessibility of *Quelea quelea*, this work provides the first evidence of the continuation of the wild bird business at Kelema Balai throughout the year. This may be explained by the fact that business persons collect birds from other villages, which ensures a sustainable supply of roasted wild birds meat throughout the year. Even though local communities in rural settings diversify their income sources [45], this study indicates that one-third of wild bird business actors depend on wild birds as their main source of income (Fig. 6).

Concerning *natural capital*, wild bird hunting plays an important role in the nutrition of local communities as a valuable source of protein. Approximately two-thirds of Chemba's local communities rely on wild birds as a delicacy food product. During focus group discussions, one informant quoted;

"In Chemba, wild birds are our gold. It is our natural wealth from God, as other areas are blessed with Tanzanite and gold."

Elsewhere in Africa, such as in Cameroon, Zimbabwe, and Chad, researchers have had similar findings about the role of *Quelea quelea* birds in the provision of high-quality protein [18,37,45]. Contrary to previous studies, the local communities in the study area believed that *Quelea quelea* had a high protein content that enhanced their manhood and power for the production of sperm and similarly lengthened the duration of sex to how *Quelea quelea* maintains speed and long flights. This myth adds markets to local districts and nearby cities, like Dodoma, Arusha, and Dar es Salaam. The contribution of natural capital (in this case wild birds) to the livelihood of the people is multifaceted and encompasses various dimensions in the study area. Apart from food, it adds employment and enables the local community to interact with natural resources. This concurs with [46] findings that access to natural capital may facilitate improvements to other livelihood assets such as financial capital. It also acts as a safety net especially during drought and failure of crop harvest, as stated in the statement below during an interview with wild bird hunters.

".... .wild birds business help us to have an alternative source of income during crop failureand the birds' movement and sound help us to determine and predict weather condition and crops harvest season in our villages ..."

This implies wild birds play a significant role in cultural practices which contribute to the improvement of livelihood strategies. These services are fundamental for human survival and play a crucial role in sustaining livelihood [47].

In addition, the study shows that a quarter of the actors in the wild bird business managed to acquire physical assets, which helped them to afford mainly their family's needs and livestock. The physical assets are necessary for supporting livelihood strategies. Other assets accrued from the wild bird business include bicycles, bricks, iron sheets, land, mobile phones and power tiller for farming. This implies improving household living standards including an increase in access to safe and adequate housing for individual and household members as a result of the wild birds business. Assets gained from the wild birds business could also serve as insurance as it transforms their cash holdings into assets. The same scenario has been also reported by Ref. [48] that transforming cash holding to physical assets is a mechanism to save the real value of money from the effect of livelihood vulnerability.

Consistently, findings reveal that hunters, sellers, and processors of wild birds have strong social capital built around networking and trust amongst them and beyond. This wide network enhances their ability to receive loans, earn respect, pay dowry, connect to various consumers, and solve other social problems. One of the sellers of the roasted birds states that,

"I have managed to pay the dowry for my marriage from the wild bird business income. Wild bird business gives me social respect in my village, and I have been trusted because of the wealth I have acquired from it."

This demonstrates the significant role the wild bird business plays among individuals who engage in the business to gain social trust and network, which are crucial for their sustainable livelihoods. This support [49] the argument that social network and social group support leads to higher access to information, business opportunities, social power, influence and financial assets which may provide opportunities for sustaining household livelihoods.

The hunting of wild birds has contributed significantly to *human capital* in terms of the growth of skills and hunting capability through advancement traps, which have been evolving over decades. Similarly, previous studies have found that the contribution of the wild bird business depends on hunters' skills [34,50–53]. Nevertheless, our study found that such advancements have increased the catch of wild birds and income to meet the growing demand for wild birds' meat [5,12,34,54]. Hitherto, *Quelea quelea* are pest birds, and permission for their harvesting provides a mechanism for population control to reduce crop damage. Similarly [18,55], asserted that consumption of wild birds acts as a way of compensation to subsistence farmers for the lost yield as a result of the *Quelea quelea*. Even though the wild bird business has improved the livelihoods of local communities, unregulated hunting of non-targeted species may provide a population sink. This is because there are no ecological studies conducted in the area to quantify the abundance of non-targeted species in comparison to areas without *Quelea quelea* business.

5. Conclusion

Despite the fact that this study did not investigate vulnerability aspects and the role of structures and policies in the context of the livelihood framework, it still confirms a comprehensive overview of livelihood benefits derived from the wild bird business to the extent of being regarded as "gold" by the local community members who engage in the business. It reveals the existing myth behind *Quelea quelea*, which increases demand for and growth of the wild bird business in the study area. In addition, it shows weaknesses in terms of the protection of other non-targeted species despite the existence of policies and regulations guiding wildlife resources. Consequently, we recommend that despite the different livelihoods gained from hunting and selling roasted wild bird meat, the practice in the study area should be regulated or the existing regulations enforced to ensure the health of wild bird consumers and the ecological functions of the targeted wild bird species are not compromised. We recommend further study to explore vulnerability aspects and the factors affecting structures and processes in the regulation of non-targeted bird species in the study area and the scientific documentation of the myth existing behind the *Quelea quelea* bird species in relation to men's sexual desire and performance. Eventually, our study provides socio-ecological information that may be used to design sustainable methods for the harvesting of *Quelea quelea* while protecting other non-targeted wild birds in central Tanzania and beyond that share a similar experience.

Funding statement

This research was supported by the Junior Academic Staff (JAS) funding program of the University of Dodoma, Tanzania. The content is the responsibility of the authors and does not represent the official views of the University of Dodoma.

Data availability

Data will be made available on request.

CRediT authorship contribution statement

Enock Makupa: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Writing – review & editing. **Theresia Philemon:** Conceptualization, Data curation, Investigation, Methodology, Writing – review & editing. **Japhet Ringo:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing. **Anibariki Ngonyoka:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – review & editing.

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.

Acknowledgment

We would like to thank the University of Dodoma for funding this research through BWM JAS2021. We also extend our gratitude to the communities of Chemba district, and district authorities, particularly Mr. Mohamedi Kimolo (District Natural Resources Officer)

for their wonderful support during field data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2023.e22452>.

References

- [1] K.S. Basu, in: S. Dutta (Ed.), *Anthropogenic Impact on Global Wildlife Populations: Differences between Developed and Developing Countries*, Environment Concerns and Perspectives, 2007.
- [2] S. Wicander, L. Coad, Can the provision of alternative livelihoods reduce the impact of wild meat hunting in West and Central Africa? *Conserv. Soc.* 16 (2018) 441–458, <https://doi.org/10.4103/cs.cs.17.56>.
- [3] D. Biggs, R. Cooney, D. Roe, H. Dublin, J. Allan, D. Challender, D. Skinner, *Engaging Local Communities in Tackling Illegal Wildlife Trade: Can a 'Theory of Change' Help?*, 2015.
- [4] E.J. Robinson, Resource-dependent livelihoods and the natural resource base, *annurev-resource* 8 (2016) 281–301, <https://doi.org/10.1146/annurev-resource-100815-095521>.
- [5] A.L. Brochet, W. Van Den Bossche, S. Jbour, P.K. Ndong'ang'A, V.R. Jones, W.A.L.I. Abdou, A.R. Hmoud, N.G. Asswad, J.C. Atienza, I. Atrash, N. Barbara, K. Bensusan, T. Bino, C. Celada, S.I. Cherkaoui, J. Costa, B. Deceuninck, K.S. Etayeb, C. Feltrup-Azafzaf, J. Figelj, M. Gustin, P. Kmecl, V. Kocevski, M. Korbeti, D. Kotrosan, J.M. Laguna, M. Lattuada, D. Leitão, P. Lopes, N. López-Jiménez, V. Lucić, T. Micol, A. Moali, Y. Perlman, N. Piludu, D. Portolou, K. Putilin, G. Quaintenne, G. Ramadan-Jaradi, M. Ružič, A. Sandor, N. Sarajli, D. Saveljić, R.D. Sheldon, T. Shialis, N. Tsiopelas, F. Vargas, C. Thompson, A. Brunner, R. Grimmer, S.H.M. Butchart, Preliminary assessment of the scope and scale of illegal killing and taking of birds in the Mediterranean, *Bird. Conserv. Int.* 26 (2016) 1–28, <https://doi.org/10.1017/S0959270915000416>.
- [6] I. Blackie, The impact of wildlife hunting prohibition on the rural livelihoods of local communities in Ngamiland and Chobe District Areas, Botswana, *Cogent Social Sciences* 5 (1) (2019), <https://doi.org/10.1080/23311886.2018.1558716>.
- [7] Bright O. Kankam, A. Haruna A. Predicting residents' intention to conserve the hooded vulture (*Necrosyrtes monachus*) in the Birem North District, Ghana. <https://doi.org/10.1016/j.heliyon.2020.e04966>, Heliyon 6, 2020.
- [8] D. Roe, F. Booker, Engaging local communities in tackling illegal wildlife trade: a synthesis of approaches and lessons for best practice, *Conserv. Sci. Pract.* 1 (2019) e26, <https://doi.org/10.1111/CSP2.26>.
- [9] R. Primack, *Essentials of Conservation Biology*, fifth ed., Sinauer Associates, Inc. China, 2010.
- [10] F. Magige, T. Holmern, S. Stokke, C. Mlingwa, E. Røskaft, Does illegal hunting affect density and behaviour of African grassland birds? A case study on ostrich (*Struthio camelus*), *Biodivers. Conserv.* 18 (5) (2009) 1361–1373, <https://doi.org/10.1007/S10531-008-9481-6>, 2008.
- [11] A.J. Clarke, A. Babic, Wildlife trafficking trends in sub-Saharan Africa, in: OECD (Ed.), *Illicit Trade: Converging Criminal Networks*, OECD Reviews of Risk Management Policies, OECD Publishing, 2016, pp. 57–77, <https://doi.org/10.1787/9789264251847-6-en>.
- [12] H. Fernandes-Ferreira, S. Mendonça, C. Albano, F.S. Ferreira, R.R. Alves, Hunting, use and conservation of birds in Northeast Brazil, *Biodivers. Conserv.* 21 (2011) 221–244, <https://doi.org/10.1007/S10531-011-0179-9>, 2011.
- [13] F. Commercon, M. Zhang, J. Solomon, Social norms shape wild bird hunting: a case study from southwest China, *Global Ecology and Conservation* 32 (2021), <https://doi.org/10.1016/j.gecco.2021.e01882>.
- [14] R. Cooney, D. Roe, H. Dublin, J. Phelps, D. Wilkie, A. Keane, H. Travers, D. Skinner, D.W.S. Challender, J.R. Allan, D. Biggs, From poachers to protectors: engaging local communities in solutions to illegal wildlife trade, *Conserv. Lett.* 10 (2017) 367–374, <https://doi.org/10.1111/CONL.12294>.
- [15] J. Kamp, S. Opper, A. Ananin, Y. Durnev, S. Gashev, N. Holzel, A. Mishchenko, S. Smirenski, E. Stelnikov, S. Timonen, K. Wolanska, S. Chan, Global population collapse in a superabundant migratory bird and illegal trapping in China, *Conserv. Biol.* 29 (6) (2015) 1684–1694, <https://doi.org/10.1111/cobi.12537>. Epub 2015 Jun 8.
- [16] Mmassy, E.C., Røskaft, E. Knowledge of birds of conservation interest among the people living close to protected areas in Serengeti, Northern Tanzania. <https://doi.org/10.1080/21513732.2013.7885669>, 114–122.
- [17] B.N. Mtobesya, *Non-Chemical Control of the Red-Billed Quelea (Quelea Quelea) and Use of the Birds as a Food Resource*, pest Manag. Sci. University of Greenwich, 2012.
- [18] F. Manyama, J.W. Nyahongo, E. Rå skaft, Factors affecting attitudes of local people toward the red-billed Quelea (*Quelea quelea*) in Kondoa District, Tanzania, *Int. J. Biodivers. Conserv.* 6 (2014) 138–147, <https://doi.org/10.5897/IJBC2013.0655>.
- [19] J. Nyahongo, Influence of seasons on the illegal harvest of red-billed quelea quelea and other birds in kondoa district, Tanzania. Institute of rural development planning (IRDP), *Rural Planning Journal* 15 (1) (2013) 119–128.
- [20] R. Chambers, C. Gordon, *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*, 1991. IDS Discussion Paper 296.
- [21] S. Loison, Household livelihood diversification and gender: panel evidence from rural Kenya, *J. Rural Stud.* 69 (2019) 156–172, <https://doi.org/10.1016/j.jrurstud.2019.03.001>.
- [22] T. Baird, J. Hartter, Livelihood diversification, mobile phones and information diversity in Northern Tanzania, *Land Use Pol.* 67 (2017) 460–471, <https://doi.org/10.1016/j.landusepol.2017.05.031>.
- [23] Y. Gautam, P. Andersen, Rural livelihood diversification and household well-being: insights from Humla, Nepal, *J. Rural Stud.* 44 (2016) 239–249, <https://doi.org/10.1016/j.jrurstud.2016.02.001>.
- [24] F. Ellis, Household strategies and rural livelihood diversification, *Journal of Development Studies* 35 (1) (1998), <https://doi.org/10.1080/00220389808422553>.
- [25] B. Musoma, S. Nyanda, M. Muhanga, F. Massawe, Gas extraction operations and livelihood diversification in Tanzania: rhetoric and reality, *Heliyon* 9 (2023), e17520, <https://doi.org/10.1016/j.heliyon.2023.e17520>, 2023.
- [26] B. Mukwede, M. Mudhara, Factors influencing livelihood strategy choice and food security among youths in Mashonaland East Province, Zimbabwe *Heliyon* 9 (2023), e14735, <https://doi.org/10.1016/j.heliyon.2023.e14735>.
- [27] S. Ken, T. Entani, T. Tsusaka, N. Sasaki, Effect of REDD+ projects on local livelihood assets in keo seima and oddar meanchey, Cambodia *Heliyon* 6 (Issue 4) (April 2020), e03802, <https://doi.org/10.1016/j.heliyon.2020.e03802>.
- [28] K. Hussein, *Livelihoods Approaches Compared: A Multi-Agency Review of Current Practice*, Finesse Print, 2018.
- [29] I. Scoones, Livelihoods perspectives and rural development, *J. Peasant Stud.* 36 1 (2009) 171–196, <https://doi.org/10.1080/03066150902820503>.
- [30] S.A. Bajwa, *Study of Status of Livelihood Assets at Household Level: Evidence from Saidpur Village, Islamabad*, Pakistan Institute of Development Economics, Department of Development Studies Discussion Paper A Study of Status of Livelihood Assets at Household Level: Evidence from Saidpur Village, Pakistan Institute of Development Economics, Department of Development Studies Discussion Paper, Islamabad, 2015.
- [31] E. Petersen, M. Pedersen, *The Sustainable Livelihood Approach. From a Psychological Perspective*, Insitute of Biology, Aarhus, 2010.
- [32] M. Kollmair, J. Gamper, *The Sustainable Livelihoods Approach*, Development Study Group, University of Zurich (IP6), 2002.
- [33] C. Ashley, D. Carney, *Sustainable Livelihoods: Lessons from Early Experience*, Department for International Development, 1999.

- [34] M. Lindenberg, Measuring household livelihood security at the family and community level in the developing world, *World Dev.* 30 (2002) 301–318, [https://doi.org/10.1016/S0305-750X\(01\)00105-X](https://doi.org/10.1016/S0305-750X(01)00105-X).
- [35] N. Natarajan, N. Andrew, R. Jonathan, S. Diana, A sustainable livelihoods framework for the 21st century, *World Dev.* 155 (2022), <https://doi.org/10.1016/j.worlddev.2022.105898>.
- [36] Swedish International Development Cooperation Agency, *The Sustainable Livelihood Approach to Poverty Reduction, An Introduction*, 2001.
- [37] S.B. Opiyo, G. Opinde, S. Letema, A perspective of sustainable livelihood framework in analysis of sustainability of rural community livelihoods: evidence from migori river watershed community in Kenya, *Int. J. River Basin Manag.* (2023) 1–41, <https://doi.org/10.1080/15715124.2023.2216019>.
- [38] S. Morse, N. McNamara, The theory behind the sustainable livelihood approach, in: *Sustainable Livelihood Approach*, Springer, 2013, pp. 15–60, https://doi.org/10.1007/978-94-007-6268-8_2.
- [39] H.A. Khuzwayo, A Sustainable Livelihood Approach to Poverty Reduction: Participatory Experiences of Women Involved in Art and Craft Cooperative in Bhambayi, 2016. <http://hdl.handle.net/10413/14830>.
- [40] F. Ellis, Household Strategies and rural livelihoods diversifications, *J. Dev. Stud.* 35 (1) (1998) 1–38.
- [41] The United Republic of Tanzania, National Agriculture Development Policy. Govt printer., 2013.
- [42] C. Elliott, B.N. Mtobesya, R.A. Cheke, Alternative approaches to red-billed quelea quelea quelea management: mass-capture for food, *Ostrich* 85 (2014) 31–37, <https://doi.org/10.2989/00306525.2014.900827>.
- [43] E. Ragheb, E.S. Akel, S.I. Rizkalla, Analyses of the non-target catch from the Egyptian mediterranean trawlers, off port said. Egypt, *J. Aquat. Res.* 45 (2019) 239–246, <https://doi.org/10.1016/j.ejar.2019.07.003>.
- [44] J. Josephine, O. Athanasia, B. Pavithravani, Contribution of the Dolichos Lablab value chain to farmer's household livelihood assets in Tanzania, *Heliyon* 8 (2022), <https://doi.org/10.1016/j.heliyon.2022.e11646>.
- [45] A.T. Daniel, W. Kebede, Climate change induced a progressive shift of livelihood from cereal towards Khat (*Chata edulis*) production in eastern Ethiopia, *Heliyon* 9 (2023), <https://doi.org/10.1016/j.heliyon.2022.e12790>.
- [46] T. Pereira, C. Shackleton, S. Shackleton, Trade in reed-based craft products in rural villages in the Eastern Cape, South Africa, *Dev. South Afr.* 23 (4) (2006) 477–495.
- [47] R.J. Nawrotzki, L.M. Hunter, T.W. Dickinson, Rural livelihoods and access to natural capital: differences between migrants and non-migrants in Madagascar, *Demogr. Res.* 26 (2012).
- [48] Pour, M., Ali Akbar, b., Hossein, A., Jürgen, S. Revealing the role of livelihood assets in livelihood strategies: Towards enhancing conservation and livelihood development in the Hara Biosphere Reserve, Iran, *Ecol. Indic.*, Volume 94, Part 1, <https://doi.org/10.1016/j.ecolind.2018.05.074.2018>.
- [49] Á. Carrillo, R.J. Riera, Measuring social capital: further insights, *Gac. Sanit.* 31 (2017) 57–61, <https://doi.org/10.1016/j.gaceta.2016.09.002>.
- [50] P.Z. Yanda, A.R. Mwajombe, B. Gwambene, Coastal Communities' Livelihoods Conditioned by Resource Use Dynamics and Changing Environments in Lindi Region, South-Eastern, Tanzania, 2023, <https://doi.org/10.1016/j.marpol.2023.105532>.
- [51] J.R. Sinclair, L. Tuke, M. Opiang, Entrapment of wetland birds: local customs and methods of hunting in krangkeng, indramayu, central java. *Ethno-ornithology birds, Indig. Peoples, Cult. Soc.* 89 (2012), <https://doi.org/10.4324/9781849774758-16>. –94.
- [52] M.H. Hilderink, I. de Winter, No Need to Beat Around the Bushmeat—The Role of Wildlife Trade and Conservation Initiatives in the Emergence of Zoonotic Diseases, 2021, <https://doi.org/10.1016/j.heliyon.2021.e07692>.
- [53] M. Bonta, Ethno-ornithology and biological conservation, in: S. Tidemann, A. Gosler (Eds.), *Ethnornithology: Birds Indigenous People Culture and Society*, Earthscan/James & James, London, 2010, pp. 13–29.
- [54] M. Muiruri, P. Maundu, Birds, people and conservation in Kenya, in: S. Tidemann, A. Gosler (Eds.), *Ethno-ornithology: Birds, Indigenous People, Culture and Society*, Earthscan/James & James, London, 2010, pp. 279–289.
- [55] C. Mpala, P. Sibanda, M. Dlamini, B. Sibanda, Are quelea birds really a menace ? Innovative use of indigenous knowledge systems in the harvesting and utilisation of quelea, *Quelea quelea lathamii*, In Hwange District of Matabeleland North Province. *Int. J. Agric. Sci.* 2 (2014) 71–81. <https://www.academia.edu/79627476>.