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FACTORS AFFECTING THE ATTITUDES OF THE LOCAL INHABITANTS OF THE KONDOA DISTRICT-TANZANIA, TOWARD THE RED-BILLED QUELEA (Quelea quelea)

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Red-billed queleas (Source: http://ds-lands.com/photo/animals/red-billed-quelea/04/)

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Abstract

Interactions between humans and the red-billed queleas in the Kondoa District have shaped the attitudes of the local inhabitants toward these birds. This bird is considered a pest of small grain cereal crops, which represent the major crops grown in the area. On the other hand, quelea birds are caught and consumed as a household food source. Furthermore, harvested birds are sold at bus stops to passengers, as well as to local villagers, as a source of household income. This study aimed to evaluate the influence of differential costs and benefits of the red-billed quelea, as well as the socio-economic factors (education level, gender, age and economic activity) that might shape the attitudes of the local inhabitants of Kondoa. To explore the attitudes of the inhabitants, a questionnaire survey was randomly conducted among 360 households in six villages within Kondoa from June to August 2012. Most of the inhabitants who incurred costs of crop damage exhibited negative attitudes toward the red-billed quelea, despite the benefits obtained from them. In contrast, those who benefitted from harvested quelea birds exhibited positive attitudes. The most important socio-economic factors influencing both the positive and negative attitudes were education and gender. In contrast, economic activity only influenced the negative attitudes. Most of the inhabitants of Kondoa rely on crop production as the only important economic activity. However, the majority of local people exhibited negative attitudes because the benefits from the red-billed quelea were perceived to be lower than the costs of the resulting crop damage. To change such negative attitudes; practical, economical and applicable solutions for the quelea pest problem are needed. Further studies examining the application of harvesting methods with a sustainable quelea management strategy are therefore recommended.

Key words: Attitudes, costs, benefits, red-billed quelea, socio-economic factors, local inhabitants and Kondoa-Tanzania.

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List of abbreviations and acronyms

cm	centimeter
ha	hectare
HH	household
IUCN	International Union for Conservation of Nature
km	kilometer
m	meter
mm	millimeter
NBS	National Bureau of Statistics
URT	United Republic of Tanzania
Tsh	Tanzanian shilling

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INTRODUCTION

Background

The interactions between humans and wildlife have led to both positive and negative human attitudes toward conservational objectives. The positive attitudes are predominantly associated with wildlife-derived benefits, whereas the negative attitudes are created by wildlife-related costs, including the opportunity costs of conservation (Gereta & Røskaft 2010; Røskaft 2012; Røskaft et al. 2007). The growth of the human population, together with increased human activities have been described as major challenges in wildlife conservation (Dar et al. 2009; Holmern et al. 2007; Kideghesho et al. 2007; Packer et al. 2005; Røskaft 2012). This is largely due to increased interactions between humans and wildlife, which, in turn, generates conflicts as a result of competition for natural resources (Hanley et al. 2010; Treves & Karanth 2003; Treves et al. 2006). A number of species are regarded as problem animals because of their conflicts with humans in terms of crop damage, livestock depredation and human attacks (Ikanda 2010; Løe & Røskaft 2004; Packer et al. 2005). Such animals include bird pests, rodents, primates, bush pigs, ungulates, elephants, hippos, buffalos, zebras and large carnivores (Gereta & Røskaft 2010). Such conflicts significantly affect the survival of both humans, as well as wildlife, either directly or indirectly through the retaliatory killings of animals and habitat loss (Ikanda & Packer 2008; Løe & Røskaft 2004). It also creates negative attitudes for people, particularly when wildlife-related costs are increased compared to wildlife-related benefits and when compensation schemes are lacking (Holmern et al. 2007; Kideghesho et al. 2007; Nyahongo 2007).

Most countries including Tanzania have failed to fully compensate local inhabitants on wildlife-related costs due to the lack of sufficient funding, as well as to the difficulties in evaluating the exact costs and claims (Gereta & Røskaft 2010; Hemson et al. 2009; Løe & Røskaft 2004; Mfunda & Røskaft 2011). However, compensation does not guarantee positive attitudes toward problem animals (Naughton-Treves et al. 2003; Røskaft et al. 2007). Despite the problems that they cause to people, more efforts are used to conserve the so-called problem animals because of different values attached to them, either directly or indirectly, including ethical values. However, the achievements of such efforts require support from people, which is highly influenced by their attitudes toward conservation (Røskaft et al. 2007; Treves & Karanth 2003).

The red-billed quelea (Quelea quelea)

The red-billed quelea is a small passerine bird that belongs to the Ploceidae family. They have red conical bills and legs, and their body colour is mostly brown, although juveniles have pale brown bills. Adult individuals have an average body length of 12.5 cm and a body weight of 15 to 20 grams (Markula et al. 2009; Ruelle & Bruggers 1982). They reach sexual maturity at one year of age, and their life span ranges from two to three years. They are sexually dimorphic with colour changes during the breeding season (Hartley & Mundy 1999; Markula et al. 2009). According to Markula et al. (2009) bill colour of female birds change from red to a waxy bright yellow, whereas the males develop colourful plumage and a bright red bill. The male breeding plumage is variable, comprising a facial mask ringed with pink or dull yellow, which ranges from black to white. Breast and crown plumage colours can vary from yellow to bright red. However, after the breeding season, males revert to their plain brown plumage, and the bill colour of female birds reverts to their red colour.

The red-billed quelea lives in enormous populations and is most likely the most abundant wild bird in the world (de Mey et al. 2012). It has existed for many years and is categorised as of least concern under IUCN conservation status (BirdLife-International 2013; Elliott 2006; Markula et al. 2009). Such large populations exist due to the high availability of their staple food and because of their ability to follow seasonal migration into areas that have received adequate rainfall and to breed efficiently (Elliott 1979, 1990; Elliott 2006; Mullie 2000). However, it is not clear whether these birds can continue to survive in such huge numbers for the coming centuries, despite their breeding efficiency. The major challenge currently facing the red-billed quelea is a conflict with farmers due to crop damage, which results in the large numbers of quelea killings every year as a pest control measure.

The red-billed quelea lives in gregarious flocks of up to 12 million birds that roost together and breed in colonies (Cheke et al. 2012; Elliott 2000; Ruelle & Bruggers 1982). Breeding colonies can comprise up to 30 million individuals and can cover more than 100 ha with approximately 3,000 to 30,000 nests per ha (Allan 1996; Cheke et al. 2007; de Mey et al. 2012; Elliott & Bright 2007; Elliott 2006; Hartley & Mundy 1999; Markula et al. 2009; Ruelle & Bruggers 1982). The red-billed queleas comprise an estimated breeding population in excess of 1.5 billion birds. Breeding colonies occur mostly in Acacia thickets or near swamps or rivers at lowland areas of altitudes less than 1000 m. The rainfall in these areas allows them to breed 1 to 2 times every year. They normally breed during the middle of the

wet season, when both insects and fresh grass seeds are abundant, avoiding the food shortages at the beginning of wet season. This is a time of heavy damage to small grain cereal crops because it is when they breed and produce many chicks, which feed on crops that grow abundantly during this period. If the dry season starts early, breeding colonies might be abandoned; the birds migrate to other areas with adequate rainfall. Several clutches of eggs can be laid if the rainy season is prolonged (Cheke et al. 2007; Elliott 1990; Hartley & Mundy 1999; Markula et al. 2009).

The red-billed quelea is a generally granivorous bird, feeding on small grains, seeds of native annual grasses and cultivated cereal crops such as sorghum, millet, rice, wheat, oats, maize, sunflower, and barley. Sometimes, and particularly during the breeding season, the chicks feed on larval insects (Allan 1996; Cheke et al. 2007; Elliott 1979; Elliott 2006; Hartley & Mundy 1999; Markula et al. 2009; Ruelle & Bruggers 1982). Most of the cultivated cereal crops have seeds, which originated from wild grasses that are the natural food types of the red-billed quelea. In addition, most of the areas where cereal crops are grown were previously natural grasslands, a typical habitat for quelea birds. It is therefore natural for these birds to become pests of such crops (Allan 1996; Elliott & Bright 2007). Although the expansion of crop cultivation has reduced some of the grassland areas where these birds might find their native food sources, there are still sufficient remaining areas (Elliott 2006). The red billed quelea is regarded as an agricultural pest with a significant impact on crop yield (Allan 1996; Elliott 2006). They are estimated to cause an annual loss of US $ 79.4 million in 2011 in sub-Saharan countries (Cheke et al. 2012). A flock of 2 million birds can consume up to 50 tonnes of grain per day or 1500 tonnes in a month. They are capable of destroying entire crops of areas up to 1,000 ha due to their feeding behaviour and large populations (Markula et al. 2009). Just one single bird can cause yield losses of up to 10 grams of grains per day. However, only a quarter of total grain lost might be consumed, whereas the remaining portion is wasted through their feeding habits (Cheke et al. 2012).

The red-billed quelea is adapted to the semi-arid woodland and grassland habitats of the dry tropical African savannah at altitudes below 2000 m (Elliott & Bright 2007; Hartley & Mundy 1999; Markula et al. 2009). They occur exclusively in sub-Saharan Africa (de Mey et al. 2012; Elliott & Bright 2007; Elliott 2006) over an estimated area of 9,400,000 km² (BirdLife-International 2004) excluding deep portions of the rainforests in central Africa and the southern parts of South Africa. Currently the red-billed quelea is less common in Europe

and North America although in the past, they were regularly imported as pets (Markula et al. 2009). According to Magige (2008) Africa has more than 2,000 bird species which account for 20 % of the total birds found in the world. Nine-tenths of these species are endemic to Africa, whereas the rest are winter migrants from Palaearctic. Therefore, it is crucial to consider the red-billed quelea as one of the endemic species that is to Africa, in addition to other birds, in regards to biodiversity conservation.

The quelea pest problem is a serious threat to the livelihoods of farmers growing small grain cereal crops in central, eastern and southern Africa, and particularly in Tanzania, Zimbabwe, Botswana and South Africa (Cheke et al. 2012). However, this bird is also regarded as a pest in other sub-Saharan countries of western Africa (de Mey et al. 2012) and around the Lake Chad basin and Niger River delta (Allan 1996). The East African countries of Tanzania, Kenya, Somalia, Ethiopia and Sudan suffer an estimated total loss of grain worth approximately US $ 15 million annually (Markula et al. 2009). Crop losses are likely to increase if programs to intensify small grain cereal crops production are pursued without considering probable pest attacks in addition to other constraints. The efficient control of the quelea pest problem will help to increase crop production, particularly for small-scale farmers at the poverty line.

Tanzania is among the countries with the largest populations of the red-billed quelea, with an estimated post-breeding population of 124 million birds (Elliott 2006). The Kondoa District of Central Tanzania is one of the places with such a high abundance of quelea (Allan 1996) and the local inhabitants face the problem of crop damage by quelea birds. Apart from local initiatives, the government also raises efforts to control the quelea pest problem by spraying chemicals (organophosphate pesticides) from aircrafts into quelea breeding colonies and night roosts (Cheke et al. 2012). This control operation has been conducted for the last four decades, although the problem has not yet been resolved. Small-scale farmers have lost their crops to quelea birds every year because the government cannot spray chemicals over all of the areas inhabited by quelea birds, only targeting the most affected areas. Apart from crop losses to farmers, the government also incurs significant costs to perform such control operations because the chemicals used, as well as the controlling activities, are expensive.

The inhabitants of Kondoa use traditional ways to harvest the birds illegally to reduce the red-billed quelea populations. The harvested birds are consumed or sold to generate household income (Nyahongo et al. Unpublished data). Woven (traditional) traps are used to catch the birds and are usually set close to areas with water points in which one live bird and sorghum grains are positioned as a decoy and bait, respectively, to attract other birds. The traps are constructed such that the entrance becomes narrower as the bird enters, promoting its progressive entry while impairing its escape (Manyama, pers. obs. 2012). During the wet season the inhabitants of Kondoa claim to harvest more than 3,000 birds per day using both fishing nets and woven traps. However, fishing nets are currently less used due to their limited availability (Masare, pers. comm. 2012). The harvesting strategy, if well planned and coordinated between the ministries that deal with agriculture and wildlife, can help to reduce the levels of crop damage.

Despite being used by the inhabitants of Kondoa for many years, the harvesting strategy has also failed to resolve the problem of crop damage because the traps used are locally constructed and small in size. Such traps can only catch a maximum of 30 to 50 birds per trap. A better option in terms of sustainable harvesting if well coordinated is to slightly modify the traps. Such a strategy might potentially reduce the cost of chemical control and its associated direct and indirect harmful effects to humans, other non-targeted organisms and to the environment (Cheke 2003; Cheke et al. 2012; Elliott & Bright 2007; Mullie 2000). This approach appears to be the best of different suitable control measures if well organised and is being considered in policies and legal proceedings (Elliott & Bright 2007).

Human attitudes

An attitude can be defined as a way of thinking or feeling that is reflected in an individual's behaviour or particular tendency to act that is attributed to both an individual's experience and temperament (Pickens 2005). Psychologists define an attitude as a learned tendency used to evaluate things in a specific way. Such evaluations are often positive or negative, but they can also be uncertain due to mixed feelings regarding a particular situation. An attitude consists of the following three main components; affection (emotion, feeling or normative belief), cognition (knowledge, thought or opinion) and behaviour (an action) (Kideghesho et al. 2007). Attitudes can influence our decisions, guide our behaviours and impact what we

selectively remember. They can help us to define how we see situations, as well as to define how we behave towards a given situation or object.

Understanding the attitudes of the Kondoan people towards the red-billed quelea can help to provide a new basis for management actions and guide the policy and management decisions involved in the design, implementation and evaluation of the conservation and management of quelea populations. Attitudinal studies can also help to evaluate public understanding, acceptance of wildlife and the impacts of conservation programs despite the negative factors that can create negative attitudes (Dar et al. 2009; Kaltenborn et al. 2006; Kideghesho et al. 2007; Røskaft et al. 2007).

Local people are the key stakeholders of conservation because they are involved in the implementation of conservational objectives; thus, it is crucial to understand their attitudes (Kideghesho et al. 2007; Røskaft 2012). Because the inhabitants of the Kondoa District have experienced both costs and benefits of having the red-billed quelea in their vicinity, it is important to investigate their attitudes for better management actions. Although there are many factors that can affect attitudes of people either positively or negatively, positive factors can help to inspire positive attitudes, which promote conservation objectives whereas those influencing negative attitudes are often working against conservation (Kideghesho et al. 2007; Røskaft et al. 2007).

Generally, attitudes toward the conservation of wildlife are mostly influenced by the benefits that people gain, as well as the negative consequences that they acquire (Gereta & Røskaft 2010; Gillingham & Lee 1999; Hemson et al. 2009; Kaltenborn et al. 2006; Røskaft 2012; Røskaft et al. 2007). In the Kondoa District, the red-billed quelea exhibits both positive and negative factors in terms of benefits and costs to local inhabitants. The main negative factor that influences negative attitudes is crop damage, whereas the positive factors related to harvesting and use of the harvested birds promote positive attitudes. Such benefits derived from the utilisation of the harvested birds are intended to offset quelea-related costs, to promote tolerance for the pest problem and to influence positive attitudes toward the red-billed quelea.

The aim of this study was to assess how the local inhabitants of the Kondoa District assess the costs and benefits of having the red-billed quelea in their vicinity. I will test the influence of the costs and benefits of the red-billed quelea in terms of the attitudes of the inhabitants. The hypothesis to be tested is that the inhabitants who incurred crop damage costs would exhibit negative attitudes toward the red-billed quelea, whereas those who benefitted from the bird would exhibit positive attitudes. The influence of socio-economic factors on the human attitudes toward the red-billed quelea in Kondoa will also be evaluated. Lastly, I will propose management actions that might help to control quelea populations from crop damage without spraying chemicals.

Significance of the study

The results of this study will help us to understand the attitudes of local inhabitants toward quelea birds and their thoughts regarding management actions. This study will generate knowledge on how to control quelea populations through sustainable harvesting instead of using harmful chemicals. It is important to increase crop yields, especially in regard to small-scale farmers at the poverty line and to improve their livelihoods by reducing poverty via the alleviation of the quelea pest problem. The goal is to change the negative attitudes of people towards the red-billed quelea into positive attitudes following the implementation of a new harvesting control measure, which might benefit the inhabitants while solving the pest problem.

Hypotheses

The aim of this study was to test the following three hypotheses;

1. People who benefit from the red-billed quelea exhibit positive attitudes toward the bird.
2. People who experience the costs of crop damage from the red-billed quelea exhibit negative attitudes toward the bird.
3. Socio-economic factors (gender, education level, age and economic activity) influence human attitudes toward the red-billed quelea.

METHODOLOGY

Study Area

The study was conducted in six villages (Kelema Balai, Paranga, Kelema Kuu, Isini, Cheku and Sori) located within the Kondoa District of the Dodoma Region in Central Tanzania. Dodoma is a semi-arid region with an altitude ranging from 1200 m to 1500 m above sea level. The mean maximum and minimum temperatures are 31^{o} C and 18^{o} C, respectively. The mean annual rainfall varies between 600 mm and 1000 mm, which falls between November and April (URT 2013). The Kondoa District has a total population exceeding 260,000 people (NBS 2013) with a population growth rate of two percent annually and a total area of 13,210 km^{2} extending from 4^{o} 30'S to 5 ^{o} 36'S and 35^{o} 10'E to 36 ^{o} 27'E (Figure 1).

Figure 1*: Map of the study area - the Kondoa District in Central Tanzania showing the six study villages (red dots)*

The six villages comprise an area of 360.5 km^2 and a total population of more than 15,000 people (NBS 2013), with an average household size of five people. The majority of people belong to the Rangi tribe and are Muslims. In terms of main economic activities, most people are agro-pastoralists, which means that they cultivate crops and keep livestock for subsistence. The types of food crops cultivated includes pearl millet (*Pennisetum glaucum),* sorghum (*Sorghum bicolor),* groundnuts (*Arachis hypogaea),* maize (*Zea mays),* African rice (*Oryza glaberrima),* cassava (*Manihot esculenta),* and sunflower (*Helianthus annuus),* which are cash crop. The types of livestock include cattle, goats and chickens.

Despite the fact that the majority of people are agro-pastoralists, their economy is supplemented with charcoal production and local businesses that trap quelea birds for sale to passengers at bus stops and in the streets for HH consumption. The majority of the harvested birds are sold at a price of Tsh. 100- 200 (US $ 0.06-0.12), sometimes Tsh 300 (US $ 0.18) per bird when fried, Tsh. 100 (US $ 0.06) per three birds or Tsh 50 (US $ 0.03) per bird when sold as fresh meat. These combined economic activities yields an average annual income ranging between US $ 40 to $ 130 per inhabitant of Kondoa. The area has large populations of quelea birds both in roosting and breeding colonies because the birds breed in Kondoa during the wet season. Their abundance increases during wet season due to increased breeding, and more crop damage occurs at that time.

Data collection

A face-to-face interview was conducted by means of a questionnaire that assessed the human attitudes toward the red-billed quelea from June to August 2012. The purpose of the interview was to ascertain the attitudes of the local inhabitants toward the red-billed quelea and their perceptions of how this bird damages their crops. In addition, I wanted to record the benefits derived from the harvested quelea birds. To enhance the proper identification of the study species (the red-billed quelea), the respondents were asked whether they knew the species prior to the interview. All of the interviews were conducted in Swahili and conducted out by the researcher and two field assistants.

I used the triangulation method with quantitative data as primary data and qualitative data as secondary data. The quantitative data were collected at the HH level through formal, semi-structured (both close and open ended) questionnaire surveys to different groups of men and women who were at least 18 years of age. The survey involved respondents from a randomly selected sample of 360 HHs drawn from the six study villages. The purpose of the

random HH selection was to include as many different socio-economic conditions as possible. The villages included were Kelema Balai (n = 60), Paranga (n = 60), Kelema kuu (n = 60), Isini (n = 60), Cheku (n = 60) and Sori (n = 60) (Figure 1).

A household was defined as a person or group of people living together in the same compound, who share some common living arrangements and are responsible to the same household head (NBS 2013). In the HH, the head of the family was selected for the interview, and when the head was absent, any adult of at least 18 years age was selected. The main collected information included the respondents' age, sex, education level, household size and economic activities. The information regarding the costs and benefits of the red-billed quelea to local communities and people's attitudes toward the bird were collected from attitude-testing questions listed in Annex 1.

The qualitative data were collected through informal interviews, focused group discussions and literature reviews to supplement the quantitative data in terms of the discussion-related information. The main stakeholders for the interviews and group discussions were the local inhabitants, village leaders and the staff of the local government at the Kondoa District specifically from three departments (natural resources, agriculture and planning) because of their interactions with quelea-related matters and local communities within the area. The key words for the discussions were the costs and benefits of quelea to local communities, quelea abundance and distribution, as well as the quelea pest management programs.

Data Analysis

Data analyses were performed using SPSS (the Statistical Package for the Social Sciences, version 20). Chi-square tests and binary logistic regression analyses were applied to test the differences between the dependent, as well as the independent variables with a significance level of $p < 0.05$. Almost all of the data were non-parametric. Thus, most of the analyses were performed using non-parametric descriptive statistics and statistical tests.

The χ^2 analyses were used to test the association between the positive attitudes and quelea benefits and the negative attitudes and quelea-related costs. Binary logistic regression analyses were used to test the influence of socio-economic factors and their interactions as independent variables with the positive and negative attitudes of Kondoan people towards the red-billed quelea as dependent variables.

RESULTS

Demographic and socio-economic characteristics

The general characteristics of 360 respondents who were selected from HHs in six villages within Kondoa District for the interview are listed in Table 1. The majority of the interviewed people were men (53.6 %; Table 1). Almost all of the subsistence farmers grew food crops such as sorghum, millet, groundnuts, maize, rice and sunflower as cash crop, as well as charcoal production as extra economic activity. Other economic activities in the area were local businesses that harvested quelea birds, which were sold in the streets to local inhabitants and at bus stops to passengers.

***Table 1**: Demographic and socio-economic characteristics of the respondents (N = 360)*

Category	Indicator	Frequency	%
Sex	Males	193	53.6
	Females	167	46.4
Age group	18-36 years	134	37.2
	37-54 years	145	40.3
	55 years and above	81	22.5
Education level	Illiterate	62	17.2
	Primary education	252	70.0
	Higher education	46	12.8
Economic activity	Subsistence farming	327	90.8
	Local business	33	9.2

Knowledge regarding the red-billed quelea and its abundance

In the survey, 98.6 % (N = 360) recognised the red-billed quelea and had seen them at different places such as farmlands (64.2 %), along the river (31.1 %) and in wilderness areas (4.7 %). The abundance of quelea was assessed by asking people whether the number of harvested birds was increasing or decreasing. Of all of the respondents, 68.6 % claimed that the numbers of harvested quelea were increasing, whereas 31.4 % claimed that the numbers of harvested quelea were decreasing.

Interestingly, 77.8 % (N = 9) of those who claimed that quelea birds were not harvested in the area said that the quelea populations were decreasing. On the other hand only 29.9 % (N = 351) of those who claimed that quelea birds were harvested in the area said that the quelea populations were decreasing (χ^2 = 9.38, df = 1, N_{tot} = 360, P = 0.002).

Among the respondents who claimed that the quelea populations were increasing (68.6 %, N = 247), 40.6 % claimed that it was due to the breeding efficiency of the birds, 31.9 % claimed that it was due to food availability within the area and 27.5 % claimed that it was due to both breeding efficiency and food availability.

Of those who claimed that quelea populations were decreasing (31.4 %, N = 360), 73.5 % (N = 113) of the respondents claimed the decrease was due to spraying of chemicals. Of these respondents, 49.4 % (N = 113) of the respondents claimed that the decrease was both due to over-harvesting, as well as the spraying of chemicals.

Positive values of the red-billed quelea (benefits)

Harvesting of the quelea birds

The majority of respondents (97.5 %, N = 360) reported that the red-billed queleas were harvested in their areas, and no significant differences were found between men and women (Table 2). Most people claimed that the majority of the harvesting occurred during the wet season (73.5 %, N = 351), whereas a minority claimed that the harvesting occurred during the dry season (26.5 %, N = 351). Among the tools used for harvesting, woven traps (63.2 %, N = 351; Figure 2) were claimed to be used more often than fishing nets (36.8 %, N = 351).

***Figure 2**: A woven trap (Photo: F. Manyama)*

Utilisation of the harvested quelea birds

Regarding the utilisation of the harvested quelea, 95.6 % (N = 360) of the respondents claimed that harvested birds were both consumed and sold. For the birds that were sold, 87.5 % (N = 348) claimed that both the streets and bus stops represented the common market places. When sold, 60.8 % (N = 348) of the respondents claimed that the birds were sold as snacks (fried) or fresh meat. No differences in any of these observed variables were significant between men and women (Table 2).

Table 2*: The responses of men and women to different questions regarding quelea birds (N = 360)*

Variable	Males %	Females %	Total %	χ^2	P	df
Occurrence of quelea harvesting	96.9	98.2	97.5	0.63	0.43	1
Harvested birds were consumed	96.9	99.4	98.1	2.95	0.85	1
Harvested birds were sold	96.4	97.0	96.7	0.11	0.74	1
Harvested birds were sold at bus stops	98.4	98.1	98.3	0.29	0.86	1
Harvested birds were sold within streets	93.5	89.5	91.7	1.85	0.17	1
Harvested birds were sold when fried	99.5	98.1	98.9	0.32	0.25	1
Harvested birds were sold as fresh meat	63.4	64.2	63.8	0.02	0.88	1

Positive attitudes of the local inhabitants toward the red billed quelea

The red-billed queleas are generally accepted by inhabitants because of their benefits to humans. Seventy-eight percent (N = 282) of those who valued quelea as food expressed a like for them, whereas 30.8 % (N = 78) of those who did not value quelea as food expressed a similar like (χ^2 = 62.4, df = 1, N_{tot} = 360, P < 0.001). Most of the respondents (76.6 %, N = 282) who valued quelea as food agreed that it is a beautiful bird that deserves to live in nature like other living creatures, whereas 39.7 % (N = 78) of those who did not value quelea as food

agreed with this notion (χ^2 = 38.5, df = 1, N_{tot} = 360, P < 0.001). The majority (86.7 %, N = 256) of respondents who agreed that quelea birds have some economic benefits liked them, whereas only 21 % (N = 104) of those who did not see any economic benefits of quelea birds liked them (χ^2 = 145.6, df = 1, N_{tot} = 360, P < 0.001). Furthermore, 85.9 % (N = 256) of the respondents who claimed that the red-billed quelea has economic benefits agreed that it is a beautiful bird that deserve to live in nature like other living creatures, whereas 26 % (N = 104) of those who claimed that quelea has no economic benefits agreed with this notion (χ^2 = 123.5, df = 1, N_{tot} = 360, P < 0.001).

Moreover, approximately half of the respondents exhibited a significantly positive (48.1 %, N = 360) attitude because they agreed upon all five positive attitude statements toward the red-billed quelea (Table 3). In contrast, only 40.5 % (N = 360) of the respondents exhibited a significantly negative attitude because they agreed upon all four negative attitude statements towards the red-billed quelea (Table 3). However, the overall analysis of all attitude-testing questions revealed that most of the respondents exhibited negative attitudes (96.7 %) over positive attitudes (75.0 %).

***Table 3**: Responses of the inhabitants to questions testing their attitudes toward queleas (N = 360)*

Questions for positive attitudes (agreed)	N	% Agreed
Do you value quelea as food?	282	78.3
Do quelea have economic benefits?	256	71.1
Do you like quelea birds?	244	67.8
Do you like quelea because of its benefits?	227	63.1
Do you agree that quelea is a beautiful bird that deserves to live in nature like other living creatures?	247	68.6
Questions for negative attitudes (agreed)		
Do you regard quelea as a pest?	351	97.5
Do you hate quelea because of crop damage?	257	71.4
Do you agree that quelea is the biggest pest problem?	288	80.0
Do you agree that the red-billed quelea is a pest that should be exterminated from nature?	183	50.8

Negative values of the red billed quelea (costs)

Most of the respondents (80 %, N = 360) reported that quelea birds were the biggest pest problem in the area (Table 3). Furthermore, almost all of the respondents (97.5 %, N = 360) claimed that crop damage affected their livelihoods.

Most of the respondents (96.9 %, N = 349) had previously experienced crop depredation, of which 71.1 % (N = 349) of the respondents solely attributed their losses to the quelea birds, whereas most of the remaining respondents (25.8 %, N = 349) claimed that the depredation was attributed to a combination of birds and other pest animals.

Of all of the 360 respondents, 71.4 % claimed that both millet and sorghum were the most quelea-affected crops, whereas other crops such as rice (16.9 %) and sunflower (11.7 %) were the lease affected compared to the first two mentioned.

Tolerance levels for the loss of crops caused by quelea were different between men and women (χ^2 = 21.3, df = 3, N_{tot} = 360, P < 0.001). Although the majority of people were found to be intolerant, women were relatively less tolerant than men (Figure 3).

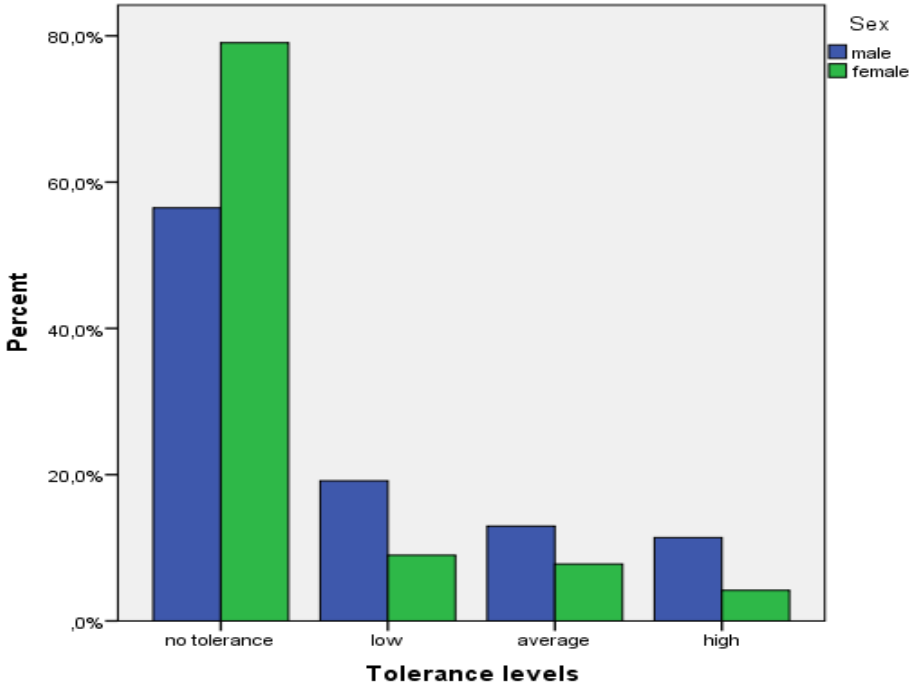

***Figure 3**: Responses of men and women on the tolerance levels of crop loss by the red-billed quelea*

Strategies used by the inhabitants of Kondoa to prevent crop depredation by quelea birds

Scaring (48.1 %, N = 360) was the most used method by local people to prevent crop depredation from quelea birds, followed by spraying of chemicals (31.4 %) and harvesting (20.6 %). The spraying of chemicals (60.6 %, N = 360) was claimed to be the most effective strategy for controlling the quelea pest problem, followed by scaring (21.7 %) and harvesting (17.8 %).

Negative attitudes of the local inhabitants toward the red billed quelea

The majority of respondents (97.5 %, N = 360) regarded the quelea as pests (Table 3). Furthermore, 96.9 % (N = 360) of the respondents claimed to have experienced crop depredation, of which 71.1 % of the respondents attributed their crop losses to quelea birds. Among the 96.9 % of respondents who claimed to have experienced crop depredation, 97.7 % (N = 343) regarded the queleas as pests ($\chi^2 = 28.6$, df = 1, $N_{tot} = 360$, $P < 0.001$).

However, among the respondents who regarded the queleas as pests (97.5 %, N = 360), there was no significant difference between the respondents who agreed (50.7 %, N = 360) that quelea should be exterminated from nature and those who disagreed (49.3 %, N = 360) ($\chi^2 = 0.082$, df = 1, $N_{tot} = 360$, $P = 0.774$).

Influence of socio-economic factors to human attitudes toward the red-billed quelea

Positive attitudes in relation to socio-economic factors

The most important socio-economic factors influencing the positive attitudes of the respondents were gender and education (Tables 4, 5 and 6). Men exhibited more positive attitudes than women (Tables 4, 5 and 6).

The level of education significantly influenced the attitudes of the respondents because most of the respondents with primary education (66.3 %, N = 252) agreed that they liked red-billed quelea because of their benefits. In contrast, few respondents with no formal education (61.3 %, N = 62) or with higher education (47.8 %, N = 46) agreed (Table 5). The overall binary logistic regression analysis using the same question "do you like quelea because of its benefits?" as the dependent variable and the four variables in Table 5, as well as the interaction between sex and education as independent variables, were not statistically

significant (Wald = 9.29, df = 5, P = 0.098; Table 5). Furthermore, the interaction between education and gender was significant for both questions presented in Tables 4 and 5 (Wald = 8.5, df = 5, P = 0.004; Table 4 and Wald = 8.32, df = 5, P = 0.004; Table 5, respectively). In contrast, the overall statistics of a binary logistic regression analysis was significant only for the question presented in Table 4 (Wald = 11.57, df = 5, P = 0.041; Table 4).

The remaining demographic variables of age and economic activity had no significant influence on positive attitudes (Tables 4, 5 and 6).

***Table 4**: Positive attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you like quelea birds?", as well as the results of a binary logistic regression analysis with the categorical variables and the interaction between sex*education as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	74.1	7.6	0.006	1	7.6	0.006
	Females	167	60.5					
Age	18-36 years	134	70.1	2.13	0.34	2	0.001	0.991
	37-54 years	145	63.4					
	55 years and above	81	71.6					
Education level	Illiterate	62	69.4	1.99	0.369	2	1.13	0.287
	Primary school	252	69.0					
	Higher education	46	58.7					
Economic activity	Subsistence farming	327	68.8	1.73	0.188	1	1.73	0.188
	Local business	33	57.6					
Interaction between education*sex in a binary logistic regression						1	8.5	0.004
Overall statistics of a binary logistic regression analysis						5	11.57	0.041

***Table 5**: Positive attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you like quelea because of its benefits?", as well as the results of a binary logistic regression analysis with the categorical variables and the interaction between sex*education as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	68.9	6.13	0.01	1	6.13	0.01
	Females	167	56.3					
Age	18-36 years	134	64.2	1.11	0.58	2	0.04	0.84
	37-54 years	145	60.0					
	55 years and above	81	66.7					
Education level	Illiterate	62	61.3	5.78	0.05	2	1.4	0.237
	Primary school	252	66.3					
	Higher education	46	47.8					
Economic activity	Subsistence farming	327	63.6	0.47	0.49	1	0.46	0.49
	Local business	33	57.6					
Interaction between education*sex in a binary logistic regression						1	8.32	0.004
Overall statistics of a binary logistic regression analysis						5	9.29	0.098

***Table 6**: Positive attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you agree that the red-billed quelea is a beautiful bird that deserves to live in nature like other living creatures?", as well as the results of a binary logistic regression analysis with the categorical variables and the interaction between education*sex as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	74.6	6.96	0.008	1	6.955	0.008
	Females	167	61.7					
Age	18-36 years	134	68.7	0.03	0.986	1	0.009	0.924
	37-54 years	145	69.0					
	55 years and above	81	67.9					
Education level	Illiterate	62	64.5	0.71	0.7	2	0.685	0.408
	Primary school	252	69.0					
	Higher education	46	71.7					
Economic activity	Subsistence farming	327	68.5	0.02	0.888	1	0.02	0.888
	Local business	33	69.7					
Interaction between education*sex in a binary logistic regression						1	1.943	0.163
Overall statistics of a binary logistic regression analysis						5	8.27	0.142

Negative attitudes in relation to socio-economic factors

Gender, education and economic activity significantly influenced negative attitudes, whereas age did not (Tables 7, 8 and 9).

Most of the respondents (98.8 %, N = 252) with primary education regarded queleas as pests (Table 7), and in response to another question, 81.3 % (N = 252) of these respondents agreed that it is the biggest pest problem in the area (Table 8).

Based on the main economic activities, a significant percentage of inhabitants whose major economic activity was farming (98.5 %, N = 327) regarded the quelea as pests (Table 7), and in another question, 81.7 % (N = 327) of these people agreed that it is the biggest pest problem in the area (Tables 8).

Gender elicited a significant influence on the negative attitudes because an increased percentage of women (59.9 %, N = 167) were observed to exhibit more negative attitudes than men (43.0 %, N = 193), by accepting the notion that quelea should be exterminated from nature (Table 9).

***Table 7**: Negative attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you regard quelea as a pest?", as well as results of a binary logistic regression analysis with the categorical variables and the interaction between education*sex as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	97.4	0.01	0.906	1	0.014	0.906
	Females	167	97.6					
Age	18-36 years	134	96.3	1.58	0.454	1	0.556	0.456
	37-54 years	145	98.6					
	55 years and above	81	97.5					
Education level	Illiterate	62	96.8	9.15	0.01	2	2.203	0.138
	Primary school	252	98.8					
	Higher education	46	91.3					
Economic activity	Subsistence farming	327	98.5	13.8	0.001	1	13.8	0.001
	Local business	33	87.9					
Interaction between education*sex in a binary logistic regression						1	1.516	0.218
Overall statistics of a binary logistic regression analysis						5	17.1	0.004

***Table 8**: Negative attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you agree that quelea is the biggest pest problem?", as well as the results of a binary logistic regression analysis with the categorical variables and the interaction between education*sex as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	81.3	0.47	0.492	1	0.472	0.492
	Females	167	78.4					
Age	18-36 years	134	75.4	3.33	0.19	1	3.263	0.071
	37-54 years	145	81.4					
	55 years and above	81	85.2					
Education level	Illiterate	62	85.5	7.74	0.02	2	6.061	0.014
	Primary school	252	81.3					
	Higher education	46	65.2					
Economic activity	Subsistence farming	327	81.7	6.08	0.01	1	6.08	0.014
	Local business	33	63.6					
Interaction between education*sex in a binary logistic regression						1	1.516	0.218
Overall statistics of a binary logistic regression analysis						5	11.26	0.046

The overall statistics of a binary logistic regression analysis using the three questions in Tables 7, 8 and 9 as dependent variables and the four demographic variables, as well as the interaction between sex and education as independent variables, were significant for each question (Tables 7, 8 and 9). In contrast, the interaction between sex and education was significant only for the question presented in Table 9 (Wald = 5.91, df = 5, P = 0.041; Table 9).

***Table 9**: Negative attitudes of people in relation to socio-economic characteristics as a response to the question, "Do you agree that quelea is a pest that should be exterminated from nature?", as well as results of a binary logistic regression analysis with the categorical variables and the interaction between education*sex as independent variables (N = 360).*

				Chi square tests			binary logistic regression	
Category	**Indicator**	**N**	**% Agreed**	**χ^2**	**P**	**df**	**Wald**	**P**
Sex	Males	193	43.0	10.2	0.001	1	10.20	0.001
	Females	167	59.9					
Age	18-36 years	134	48.5	1.88	0.391	1	0.001	0.994
	37-54 years	145	55.2					
	55 years and above	81	46.9					
Education level	Illiterate	62	46.8	1.28	0.526	2	0.001	0.979
	Primary school	252	52.8					
	Higher education	46	45.7					
Economic activity	Subsistence farming	327	51.7	1.03	0.311	1	1.03	0.311
	Local business	33	42.4					
Interaction between education*sex in a binary logistic regression						1	5.908	0.041
Overall statistics of a binary logistic regression analysis						5	11.55	0.041

Secondary data for quelea abundance, distribution and management programs from the Kondoa District council

The number of the red-billed quelea in Kondoa was estimated at more than 100 million birds, which are distributed throughout the district but particularly in areas near water sources. The response of the government to reported cases of quelea by the local inhabitants was to survey and assess the most affected areas. Among the reported areas, 37 villages were visited in April 2012 by government officials prior to the decision to apply chemical control methods. The most affected crops identified were millet, sorghum and sunflower. After a survey, the government officers selected five areas for the chemical control operation (Table 10).

***Table 10**: Estimated number of quelea killed and total costs of the chemical control operation conducted in 2012 in some areas of Kondoa District (source; District council)*

Date	Village name	Co-ordinates	Colony or Roost	Area (ha)	Quelea killed (Million)	Chemical used (litre)	Operational cost (US $)
21/4/12	Chubi	S 04^0 27' 769" E 035^0 58' 692"	Breeding colony	60	3	85	**998**
22/4/12	Chubi	S 04^0 27' 995" E 035^0 57' 765"	Roost	50	0.5	10	**245**
23/4/12	Chubi	S 04^0 32' 706" E 035^0 59' 681"	Roost	100	4	100	**1092**
24/4/12	Chubi	S 04^0 32' 706" E 035^0 59' 681"	Roost	10	2	25	**348**
25/4/12	Itaswi	S 04^0 33' 994" E 035^0 56' 037"	Roost	10	1.5	30	**394**
Total				**230**	**11**	**250**	**3077**

DISCUSSION

The red-billed quelea is among the major pests of small grain cereal crops throughout semi-arid areas of sub-Saharan Africa (Cheke 2003; Dallimer & Jones 2002; Elliott 1979; Mullie 2000; Ruelle & Bruggers 1982). This is most likely due to the expansion of their distribution range and population size from 10 to 100 times since the 1970s as a result of the increased availability of their food sources, including cereal crops (Elliott & Bright 2007; Markula et al. 2009). As a way to protect cereal crops using chemical measures, both direct and indirect hazards can occur from the spray application and consumption of contaminated food (Cheke et al. 2012). For instance, in Kondoa, quelea birds are used as food, and sometimes, the local inhabitants collect contaminated birds for consumption immediately after chemical spraying (Masare, pers. comm. 2012). This has happened even in other parts of Africa, including Chad and Cameroon, where the local inhabitants use quelea birds as food (Mullie 2000).

Similar secondary effects can occur by biomagnification via other organisms, such as when carnivorous mammals, birds and reptiles consume contaminated quelea birds. Moreover, the efficiency of chemical control remains questionable because it does not elicit a significant impact to quelea populations but rather serves as a temporary solution to crop damage within specific areas (Cheke 2003; Elliott & Bright 2007; Mullie 2000; Oschadleus & Underhill 2008). The proportion of killed birds will enhance the survival probability for the remaining populations by decreasing density-dependent mortality through food shortage, as well as reduce the competition for resources from conspecific birds (Elliott & Bright 2007; Mullie 2000). On the other hand, it is difficult to monitor the number of killed birds at any time in all treated places to ensure that the population size remains viable for future generations. However, it is relatively easy to monitor the number of harvested birds and to set limits for sustainable harvesting. Therefore, a new high efficiency control measure for the quelea birds that does not adversely impact the quelea populations, non-target species or the environment is needed in the future. The local inhabitants of the Kondoa District have been using traditional ways to catch quelea birds and to consume or sell them to gain HH income. This can be regarded as a sustainable control measure against quelea pest problem, if it is well organised by conservation authorities as one of the sustainable methods of utilising quelea birds.

Demographic and socio-economic characteristics

The general characteristics of the respondents listed in Table 1 reflect their influence on human attitudes toward the red-billed quelea. Although the interview was not gender-biased, the percentage of men involved was slightly higher than that of women. This was attributed to the fact that most of the HHs interviewed are headed by men, and in most cases, the head of the family was selected for an interview. Furthermore, priorities were given to the oldest people within the HHs, and most of them were the heads of the family. The education level is normally one of the important factors that influences human attitudes (Røskaft 2012; Røskaft et al. 2003; Røskaft et al. 2007). However, in this study, most of the respondents had primary education because it is compulsory and less expensive to attain compared to higher education. Very few respondents had higher education and were employed, whereas the majority of the remaining respondents were subsistence farmers. This shows how the people of Kondoa rely on agriculture as their main source of income, similar to other Tanzanians in rural areas. Over 50 % of the Tanzanians survive on incomes of less than US $ 1 per day, and over 80 % of that demographic lives in rural areas and depends on agriculture for their livelihoods (Gereta & Røskaft 2010; Røskaft 2012).

Knowledge regarding the red-billed quelea and its abundance

Almost all of the respondents recognised the red-billed quelea and had previously seen them at different places such as at farmlands, areas along the Kelema River and in wilderness areas. This information was useful for the investigation of the attitudes of the inhabitants because they were all familiar with the study species. The abundance of the red-billed quelea was assessed by asking the inhabitants whether the number of harvested birds was increasing or decreasing, despite the increased demand attributed to the growth of the human population. The majority of the respondents claimed that the numbers of harvested quelea were increasing, although a few respondents claimed that the numbers were decreasing. Most of those few respondents also indicated that the birds were not harvested in the area. These findings show how these few people were inaccurate compared to the observed situation in the study sites and to what the majority of respondents had indicated. In addition, another few respondents, who also claimed that quelea populations were declining, proved that harvesting had occurred every year. All these respondents claimed that the decline was mainly due to spraying of chemicals followed by over-harvesting. The spraying of chemicals was claimed to kill large numbers of quelea because of the toxic chemicals used. In contrast, over-harvesting

was considered as the least concern due to insignificant numbers of killed birds through harvesting compared to the spraying of toxic chemicals. Most respondents perceived the quelea populations as significantly abundant because their numbers have been increasing particularly during the wet season. Breeding efficiency, followed by food availability, was claimed as the major reason for the enormous quelea populations in Kondoa. Similar reasons have also been reported by others (Cheke 2003; Cheke et al. 2007; Dallimer & Jones 2002; Elliott 2006; Venn et al. 2003); the availability of their food types and the ability of the quelea to follow the movements of the Inter-Tropical Convergence Zone increases their chances to breed successfully.

Positive values of the red-billed quelea (benefits)

Harvesting of the quelea birds

Most of the respondents reported that the quelea birds were harvested in their areas during both seasons of the year but mostly during the wet season (November to April). In Kondoa, enormous quelea populations occur during the wet season following the breeding season. The quelea use this time to breed because of the high abundance of growing cereal crops that can provide adequate amount of food for their juveniles (Allan 1996). The juveniles are the most destructive birds compared to adults because they lack experience in searching for their preferred natural foods (Cheke et al. 2012; Hartley & Mundy 1999; Jones et al. 2002). People claimed to harvest large numbers of quelea birds, particularly juveniles during that period. Among the tools used for harvesting, woven traps were claimed to be used more often than fishing nets because fishing nets were banned in Tanzania as a strategy to prevent the fishing of young fishes.

Utilisation of the harvested quelea birds

Harvested quelea birds were mostly used as food within HHs, whereas some were sold to passengers at bus stops or to other HHs within the area. However, the main utilisation of these birds was food to people in their HHs, despite being sold fried or as fresh meat. According to the nature of the area, there were few other sources of protein food, including meat and it is expensive to produce meat in the semi-arid area of Kondoa, where shortages of water and green pastures are common during dry season. Therefore, quelea birds served as one of the main sources of protein in the area. This form of utilisation helped people to perceive the red-billed quelea as a bird with some value to humans.

Positive attitudes of the local inhabitants toward the red-billed quelea

The red-billed quelea was perceived as good and accepted by local people because of its values, which were beneficial to humans. This support the first hypothesis that positive attitudes of people towards the red-billed quelea are influenced by the quelea benefits. The majority who valued quelea as food liked it and accepted existence of quelea in their areas as one of the food sources for their HHs. Very few people exhibited positive attitudes that were not associated with benefits because they liked the quelea and supported its existence, although they did not value it as food. The opportunity of using quelea birds as food created positive attitudes in people because most of them had experienced this type of benefit despite the costs caused by quelea pests. The Quelea benefits were also recognised economically by people who trapped quelea birds for selling. The majority of these people liked these birds and claimed to support quelea existence so that their business could continue to develop both inside and outside Kondoa.

Approximately half of the respondents indicated significantly positive attitudes as they agreed to all of the five positive attitude statements toward the red-billed quelea. However, the overall assessment of all positive and negative attitudes testing questions showed that more respondents exhibited negative attitudes than positive attitudes. Thus most people perceived the red-billed quelea negatively despite their benefits. This attributed to the fact that the costs resulting from the crop damage incurred by the quelea were perceived to be higher compared to the benefits obtained from the harvesting of the quelea birds.

Negative values of the red billed quelea (costs)

The red-billed quelea reportedly represents the biggest pest problem in Kondoa and is predominantly responsible for crop damage in the area compared to other pests. Enormous populations of quelea birds in Kondoa were proposed to underlie their significant destruction of crop fields. The quelea pest problem has affected the livelihoods of the inhabitants of Kondoa, almost all of whom claimed to be intolerant for the quelea birds. It is very rare for local people to tolerate wildlife costs without compensation (Mfunda & Røskaft 2011).

Millet and sorghum were claimed to be the crops that were the most affected by quelea, followed by rice. Similar crops have also been reported as the most vulnerable to quelea pests in other areas (Allan 1996; Elliott & Bright 2007; Ruelle & Bruggers 1982). The two crops have been the most widespread cereal crops cultivated in many parts of Africa for

centuries and they are indigenous to the continent. They also resemble the native food of quelea because their seeds also originated from wild grass seeds. In addition, small grain cereal crops are more drought resistant crops that can grow well in semi-arid areas such as Kondoa, which is also one of the natural habitats for the red-billed quelea. Millet and sorghum are more attractive food sources to seed-eating birds such as the quelea due to their small sized grains, for which quelea exhibit a dietary preference. Grain-eating birds are not only attracted to eat the good quality crops in large farms but also to the crops on poorly cultivated farms because they offer varieties of weed seeds and insects in addition to cereal grains (Allan 1996). Poorly cultivated fields that can attract quelea pests are common in Kondoa due to poor farming practices.

Strategies used by the inhabitants of Kondoa to prevent crop depredation by quelea birds

All of the control measures for quelea are categorised into the following two main types; scientific and traditional measures. Both control measures work in the following two ways; pest population suppression and crop protection. The effectiveness of all of the management techniques depends on many factors including pest species and their biology, pest population size, farm size and ownership, value of crop being damaged, type and stage of the crop, time of the year or season, resources available for control operation and human attitudes toward the chosen control method (Allan 1996; Ezealor & GilesJr 1997; Ruelle & Bruggers 1982).

Despite of being tedious and time-consuming, bird scaring was predominantly used by local inhabitants of Kondoa to protect crops against quelea birds and other pests. Scaring the birds away has been practiced in various traditional forms using noise-making objects such as plastic, papers and cloth flags attached to a line of cords tied to poles. Scaring birds away can also be accomplished using guards or scarers that roam around the field, whipping, clapping, shouting and throwing stones. Scaring methods have been employed by traditional farmers in different parts of Africa over centuries as the first option for small scale farmers (Allan 1996; Ruelle & Bruggers 1982). Despite all of the facts, the scaring strategy was observed to have little impact on the alleviation of quelea pest problem (Allan 1996; Garanito et al. 2000).

Figure 4: *A photo of one of the birds scaring strategy in a rice field at Kondoa (Photo: F. Manyama)*

Spraying of chemicals has been claimed to represent a more effective strategy for controlling the quelea pest problem than bird scaring or harvesting. The people of Kondoa have perceived it as the most effective method simply because it kills larger numbers of queleas within a shorter period of operational time. However, chemical control is expensive to implement and also elicits hazardous effects for humans and other non-targeted organisms (Cheke 2003; Cheke et al. 2012; Elliott & Bright 2007). The fact that the people of Kondoa did not incur any chemical control-associated cost was another reason for their perception; it was the best control measure, in addition to the possibility of collecting the nearly dead birds for their own consumption. Furthermore, the majority of local inhabitants know less about the harmful effects of such chemicals. Despite the fact that chemical control still remains the major strategy for crop protection practiced in several African countries affected by the red-billed quelea, which remain a major problem to farmers, its effectiveness is still questionable (Cheke 2003; Elliott & Bright 2007; Elliott 1979; Mullie 2000).

The harvesting method has also been used by some people in Kondoa as to control quelea populations and to reduce the level of crop damage caused by these birds. It was also performed as a way to amass quelea birds as food for HHs, as well as a business for generating income through selling of the harvested birds. Furthermore, the harvesting of quelea birds in Kondoa has played a significant role in shaping positive attitudes of the local people of Kondoa towards these birds. Traditionally, quelea birds have been used as food sources by rural communities in some African countries, including Tanzania, for many years (Mullie 2000). Harvesting birds that are considered as pests also represents a way of

compensating subsistence farmers for the lost yields by using those birds as food or as a source of cash income (Allan 1996). This is the case not only in Kondoa but also in other parts of Africa (Mullie 2000) because the resulting benefits failed to compensate for even half of the crop yield losses. Even the majority of those who were engaged in the quelea business claimed that the benefits were less compared to the costs of crop damage. Nonetheless, the inhabitants have continued this business to overcome poverty through the income generated from quelea bird sales, while attempting to solve the quelea pest problem. Most of these people advocated the legalisation of the harvesting and selling of quelea birds because this otherwise illegal trade represented a way in which they struggled for their livelihoods. The people of Kondoa also require support from the government for better facilities and a more reliable market inside and outside of Kondoa. The claims of the Kondoan people need to be considered by both scientists and policy makers in order to promote sustainable development in Kondoa that will favour both the local inhabitants and wildlife conservation to benefit present and future generations, which is of utmost importance.

Negative attitudes of the local inhabitants toward the red-billed quelea

The majority of respondents consider the queleas as pests and claim to have experienced crop damage that has resulted predominantly from quelea birds. Crop damage is among the major constraints facing crop production in Kondoa, along with drought, lack of agricultural inputs, poor soils, diseases and other pests. Almost all respondents claimed that crop damage affects their livelihoods. It increases the problem of food insecurity, which is common in semi-arid areas of Tanzania, as well as other parts of Africa (Mfunda & Røskaft 2011). Approximately half of respondents agreed that quelea should be exterminated from nature because of their role as a major pest of small grain cereal crops in the area. However, among the majority of respondents who regarded the queleas as pests, almost half expressed a positive attitude by disagreeing with such a statement, indicating that the local people in Kondoa consider the values of the red-billed quelea in their livelihoods despite their associated crop damage costs.

Some inhabitants were ambivalent, but those who were engaged in the business of selling harvested quelea birds exhibited more positive attitudes than those who did not particularly farmers. Most of the farmers had strong negative attitudes toward quelea birds, despite the fact that they had also used them as food in their HHs. This observation supports the second hypothesis that negative attitudes are highly influenced by quelea-related costs.

According to Ezealor and GilesJr (1997) the negative attitudes might also be partially attributed to the lack of community participation in decision making and other aspects of wildlife management, despite the considerable agricultural losses. Similar reasons were observed in Kondoa because the local inhabitants were not involved in the decision-making process for the implementation of quelea management methods. Ultimately, the government offered assistance due to their complaints and when the problems escalated.

Influence of socio-economic factors to human attitudes toward the red-billed quelea

Positive attitudes in relation to socio-economic factors

Although the costs and benefits associated with the red-billed quelea elicited strong influences on the attitudes of the people of Kondoa, other influences were associated with the socio-economic factors. This observation supports the third hypothesis that socio-economic factors can influence human attitudes. Factors such as level of education, gender and economic activities have also been reported to influence human attitudes toward wildlife (Kideghesho et al. 2007; Naughton-Treves et al. 2003; Røskaft et al. 2007). The most important socio-economic factors observed to influence positive attitudes were gender and education. Although both men and women claimed to benefit from quelea birds, the men were observed to express more positive attitudes than women. This finding was attributed to the costs and benefits analysis. The men, who were more involved in the quelea business, received more benefits than women, who were less involved. Education and its interaction with gender proved to influence positive attitudes. Although the majority of people with primary education were peasants and were the most affected by the quelea pests, they expressed some positive attitudes toward the red-billed quelea.

Negative attitudes in relation to socio-economic factors

Despite how the local people might have benefitted from the red-billed quelea, the negative attitudes toward wildlife might have resulted from general variation of attitudes among social groups (Gereta & Røskaft 2010). Education level, economic activities and gender significantly influenced the negative attitudes of the local people in Kondoa. The level of education and economic activities were observed to be related in their influence on negative attitudes. Most inhabitants with primary education and whose major economic activity was

farming considered the red-billed queleas as pests and the biggest pest problem in their areas. These people were observed to express more negative attitudes because they were the victims of quelea-related crop damage costs.

Gender significantly influenced the negative attitudes because a higher percentage of women were observed to express more negative attitudes than men and accepted the idea that quelea should be exterminated from nature. Furthermore, although the majority of people were found to be intolerant, women were observed to be relatively less tolerant than men. In addition to the fewer benefits that women claimed to get from quelea birds, the costs of crop damage were much higher to women than to men, although both men and women incurred such costs. The majority of women incurred more costs in terms of time spent for bird scaring in the field, an activity that was performed mostly by women and children.

Secondary data for quelea abundance, distribution and management programs from the Kondoa District council

The large populations and wide distribution of the red-billed quelea throughout the Kondoa District have caused the government to rely on chemical control measures to protect crops against quelea. The spraying of chemicals currently represents the leading control measure for the quelea pest problem and is employed at the governmental level in attempts to reduce the quelea populations, particularly when they cause damage to the crops (Cheke et al. 2012; Elliott 1979). Chemical control has been used by the government in Kondoa for the last four decades. Unfortunately, there was insufficient information for previous operations prior to 2012. In practice, it is difficult and very expensive to implement this method, and it is rarely possible to relate bird killing directly to increased crop production (Elliott 1979). Only five areas out of 37 reported cases were selected for such control operations because of the associated difficulties and cost. The shortage of facilities such as airplanes that are specifically equipped for such chemical operations was also a problem. Currently, there is only one airplane for all of the East African countries that is specifically equipped for the aerial spraying of chemicals into quelea roosts and breeding colonies. In terms of the cost and benefit analysis of quelea for the local people of Kondoa, although there were no official data records, government officials have declared that the costs exceeded the benefits, and no compensation payments were extended to farmers.

CONCLUSION AND RECOMMENDATION

Conclusion

Generally, there is a need to improve agriculture to enhance the livelihoods of poor people in rural areas, and one such improvement is the control of quelea pest problem in Kondoa. The process of changing the attitudes of the people of Kondoa follows only after the identification of such attitudes, the analysis of the problems associated with negative attitudes and a solution to those problems. Both positive and negative attitudes were expressed by the inhabitants of Kondoa and were influenced by the costs and benefits of the quelea birds, as well as by socio-economic factors (gender, education level and economic activity). Crop damage induced by quelea birds was the predominant cause of negative attitudes despite the benefits obtained from the harvested quelea birds. To change such negative attitudes, practical, economical, and applicable solutions for the quelea pest problem are needed. Although attitude transformation requires time, effort, and determination, it is possible, via the implementation of various approaches including the dissemination of new information through education and awareness.

Recommendations

The harvesting of quelea birds can help to reduce the level of crop damage. An ability to forecast where and when roosting and breeding colonies might be established and to determine their breeding efficiency for sustainable harvesting will greatly improve the efficiency of current control measures. Sustainable harvesting is highly recommended because it does not significantly impact quelea populations compared to environmental factors such as drought, which can rapidly reduce their reproductive and survival fitness (Mullie 2000). The illegal harvesting of quelea birds in Kondoa is thought to have begun in 1945 as a means to obtain food for HHs. However, it currently also represents a business for some inhabitants (Masare, pers. comm. 2012, Nyahongo et al. unpublished data). I recommend the legalisation of the harvesting and selling of quelea birds in Kondoa, similar to what occurs in Chad and Cameroon (Mullie 2000) but with great consideration of sustainable harvesting. Governmental support and other relevant stakeholders are required for better facilities and a more reliable market inside and outside Kondoa. This will help to increase the benefits derived from quelea for the people of Kondoa as a way to increase tolerance for crop losses, as well as to change negative into positive attitudes.

The traditional traps used should be slightly modified to increase numbers of trapped birds within a short time and to increase the efficiency of trapping only quelea birds. The increased efficiency of trapping quelea birds will also help to solve the problem of crop damage, which is the main reason for negative attitudes of the Kondoan people towards quelea birds. Conservation education should be delivered to local inhabitants so that they can consider the value of quelea birds in their pest management actions. Furthermore, an increased knowledge of the pest species' behaviours particularly feeding and breeding is highly recommended. Lastly, the assessment of threats to quelea populations by comparing the annual variation in numbers of harvested and killed birds during chemical spraying with returns from breeding is urgently required for enhanced management decision making.

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APPENDICES

Annex 1: Questionnaire

Questionnaire survey on investigation of factors affecting the attitudes of local inhabitants of the Kondoa District-Tanzania, toward the red-billed quelea (*Q. quelea*)

Date..... Name of the village/street..... Tribe.....
GPS point..... Questionnaire No. .....

1. Age (years); 18-25 ☐ 26-33 ☐ 34-41 ☐ 42-49 ☐ 50-57 ☐ >58 ☐
2. Sex; Male ☐ Female ☐
3. Marital status; Single ☐ Married ☐ Divorced ☐ Widow ☐ Widower ☐
4. Education level; No school ☐ Primary ☐ Secondary ☐ Collage/University ☐
5. Employment; Employed ☐ Unemployed ☐
6. What is your main economic activity? Farming ☐ Livestock keeping ☐ Hunting ☐ Fishing ☐ Charcoal making ☐ Local business ☐ Others ☐
7. How many people are in your household?.....
8. Do you know quelea birds or have you ever seen them or heard about them? Yes ☐ No ☐
9. If yes, do they live in groups of which size? Small ☐ Medium ☐ Large ☐ Unknown ☐
10. What do you think about things that help them to survive in large populations? Food availability ☐ Breeding efficiency ☐ Unknown ☐
11. Have you ever seen their nest? Yes ☐ No ☐
12. If yes, where? On ground ☐ On trees ☐
13. Do they breed in colonies? Yes ☐ No ☐ Unknown ☐
14. In which season do you see these birds more often? Wet season ☐ Dry season ☐ both ☐
15. Where do you see these birds more often? On farmlands ☐ In the wilderness ☐ Along the river ☐ Other areas ☐
16. What do they do there? Feeding ☐ Breeding ☐ Other activities ☐
17. Do you regard queleas as a pest? Yes ☐ No ☐
18. What kind of crops do quelea birds prey upon? Millet ☐ Sorghum ☐ Rice ☐ Maize ☐ Sunflower ☐ Others ☐

19. Is there any other pests? Yes ☐ No ☐
20. If YES, what are they? Other birds ☐ Insects ☐ Rodents ☐ Others ☐
21. Do other pests prey on the same crops as queleas? Yes ☐ No ☐
22. When compared with the red billed quelea which one is the biggest pest problem and why? Quelea birds ☐ Others ☐ .....
23. Have your crops been damaged? Yes ☐ No ☐
24. If YES, by what kind of pest? Quelea birds ☐ Other pests ☐
25. At what stage is your crop get damaged by queleas? Maturation stage ☐ Harvesting stage ☐ Other stages ☐
26. How much can you tolerate crop loss to quelea pests? No tolerance ☐ Low ☐ Average ☐ High ☐
27. Does crop damage affect your livelihood? Yes ☐ No ☐
28. What are the strategies used to control quelea birds from crop damage? Scaring/Guarding ☐ Harvesting ☐ Spraying chemicals ☐ Others ☐
29. What do you think is the best and effective control measure of quelea against crop damage?.....
30. Is quelea harvested in your community? Yes ☐ No ☐
31. Which traps are mostly used for harvesting quelea? Woven ☐ Nets ☐ Others ☐
32. How many birds can be harvested per day? ..... by how many traps and people? People.....Traps.....
33. Does the number of harvested birds vary within years? Yes ☐ No ☐ Unknown ☐
34. If YES, does the number increases or decreases? Increase ☐ Decrease ☐
35. What do you think is the reason for decrease/increase?.....
36. What do you do with the harvested birds? Consume ☐ Sell ☐ Others ☐
37. Harvested birds are sold at what condition? Fresh meat ☐ Fried ☐ Alive ☐
38. Is there any difference in price among sold queleas? Yes ☐ No ☐
39. If YES, why?..... and what is the price per bird? Alive..... Fried.....unfried.....
40. How many birds can be sold per day?.....and where do you sell them? At the local market ☐ At bus stops ☐ On the street ☐
41. In which season do harvesting and selling of quelea birds is more often? Wet season ☐ Dry season ☐ Both ☐

42. Do you value quelea birds as a source of food in your household? Yes ☐ No ☐
43. Do quelea have cultural or aesthetic values to you and your society? Yes ☐ No ☐
44. Do quelea have economic benefits? Yes ☐ No ☐
45. Do you like quelea birds? Yes ☐ No ☐
46. Do you like quelea because of its benefits? Yes ☐ No ☐
47. Do you hate quelea because of crop damage? Yes ☐ No ☐
48. Do you agree that the red billed quelea is a beautiful bird that deserve to live in nature like other living creatures? Yes ☐ No ☐
49. DO you agree that, the red billed quelea is a pest that should be exterminated from nature? Yes ☐ No ☐