

Full Length Research Paper

## Factors affecting attitudes of local people toward the red-billed Quelea (*Quelea quelea*) in Kondoa District, Tanzania

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Interactions between humans and red-billed Queleas (*Quelea quelea*) in Kondoa District, central Tanzania, have shaped the attitudes of the local inhabitants toward these birds. These birds are considered as serious pest because they consume small grain cereal crops. The red-billed Queleas are caught and consumed as food by local communities. Harvested birds are also 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 their attitudes, a questionnaire survey was randomly conducted among 360 households in six villages 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 towards the red-billed Quelea. The most important socio-economic factors influencing both positive and negative attitudes were education and gender. In contrast, economic activity only influenced negative attitudes. To change negative attitudes towards the birds; practical, economical and applicable solutions for the Quelea pest problem are needed while considering the future conservation of the species in the area.

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

### INTRODUCTION

The interactions between humans and wildlife have led to both positive and negative attitudes toward conservation 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 and Røskaft, 2010; Røskaft, 2012; Røskaft et al., 2007).

The growth of 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 and Karanth,

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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 and Røskaft, 2004; Packer et al., 2005). Such conflicts significantly affect the survival of both humans, as well as wildlife, either directly or indirectly through retaliatory killings of animals and habitat loss (Ikanda and Packer, 2008; Løe and 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, 2010).

Most countries including Tanzania have failed to fully compensate local inhabitants on wildlife-related costs due to lack of sufficient funding, as well as to difficulties in evaluating the exact costs and claims (Gereta and Røskaft, 2010; Hemson et al., 2009; Løe and Røskaft, 2004; Mfunda and 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 and Karanth, 2003). 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 the *Quelea* pest problem in Kondo. The process of changing the attitudes of the people of Kondo follows only after the identification of such attitudes, the analysis of the problems associated with negative attitudes and a solution to those problems.

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 (Kideghesho et al., 2007). Attitudes can influence our decisions, guide our behaviours and impact what we selectively remember. 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). 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 and Røskaft 2010; Gillingham and Lee, 1999; Hemson et al. 2009; Kaltenborn et al., 2006; Røskaft 2012; Røskaft et al., 2007).

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 and Jones,

2002; Elliott, 1979; Mullie, 2000; Ruelle and 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 food sources, including cereal crops (Elliott and Bright, 2007; Markula et al., 2009). Probably due to expansion of agricultural production there is human population growth. The inhabitants of Kondo use traditional ways to illegally harvest the birds to reduce the red-billed *Quelea* populations. 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 and 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 and Bright, 2007). Understanding 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.

The aim of this study was to assess how the local inhabitants of the Kondo District assess the costs and benefits of having the red-billed *Quelea* in their vicinity. We tested the influence of the costs and benefits of the red-billed *Quelea* in terms of the attitudes of the local inhabitants. The hypothesis tested was 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 Kondo was also evaluated. Lastly, we propose management actions that might help to control *Quelea* populations from crop damage without spraying chemicals which are unselective.

## METHODOLOGY

### Study species

#### *The red-billed Quelea (Quelea quelea)*

The red-billed *Quelea* is a small passerine bird that belongs to the Ploceidae family. The red-billed *Quelea* lives in enormous populations of up to 12 million birds and is most likely the most abundant wild bird in the world (de Mey et al., 2012). 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 and Bright, 2007; Elliott, 2006; Hartley and Mundy, 1999; Markula et al., 2009; Ruelle and Bruggers, 1982). Such large populations exist due to the high availability of their food types including cereal crops, high fecundity levels as well as their ability to follow seasonal rainfall patterns into areas that have received rainfall for feeding and breeding (Elliott, 1979, 1990; 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 fecundity. 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 is adapted to the semi-arid woodland and grassland habitats of the dry tropical African savannah at altitudes below 2000 m (Elliott and Bright, 2007; Hartley and Mundy, 1999; Markula et al., 2009). These birds are generally granivorous, feeding on small grains, seeds of native annual grasses and cultivated cereal crops such as sorghum, millet, rice, wheat, oats, maize, sunflower, and barley (Allan, 1996; Cheke et al., 2007; Elliott, 1979, 2006; Hartley and Mundy, 1999; Markula et al., 2009; Ruelle and Bruggers, 1982), it is regarded as an agricultural pest with a significant impact on crop yield (Allan, 1996; Elliott, 2006). 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). 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 in 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 (queletox) from aircrafts into Quelea breeding colonies and night roosts (Cheke et al., 2012).

### Study area

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

The six villages comprise an area of 360.5 km<sup>2</sup> and a total population of more than 15,000 people (URT, 2013b), with an average household size of five people. The majority of people are mostly agro-pastoralists, cultivating crops and keeping livestock for subsistence. The main types of food crops cultivated that are into conflict with the red-billed Quelea are pearl millet (*Pennisetum glaucum*), and sorghum (*Sorghum bicolor*).

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 household consumption. The majority of the harvested birds are sold at a price ranged between Tsh. 100 and 300 (US \$ 0.06 - 0.18), per bird when fried, Tsh. 100 (US \$ 0.06) per three birds and Tsh 50 (US \$ 0.03) per bird when sold as fresh meat. These villages were selected as study sites because of the increased interactions between local people and the red-billed Quelea in terms of crop damage and illegal harvesting of the red-billed Quelea for household consumption.

### Data collection

Face-to-face interviews were 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

view 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, we wanted to record the benefits derived from the harvested Quelea birds. To assess the proper identification of the study species, the respondents were asked whether they knew the species prior to the interview. This was done by asking questions that require the respondent to identify the key observable features of the red-billed Quelea. Data were collected at the household level through formal, semi-structured (both close and open ended) questionnaire surveys to different groups of people aged 18 years and above. The survey involved respondents from a stratified random selected sample of 360 households drawn from the six study villages; Kelema Balai (n = 60), Paranga (n = 60), Kelema kuu (n = 60), Isini (n = 60), Cheku (n = 60) and Sori (n = 60) (Figure 1). The purpose of the random sampling was to include as many different socio-economic conditions as possible.

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 (URT, 2013b). In the household, 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.

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 analyses

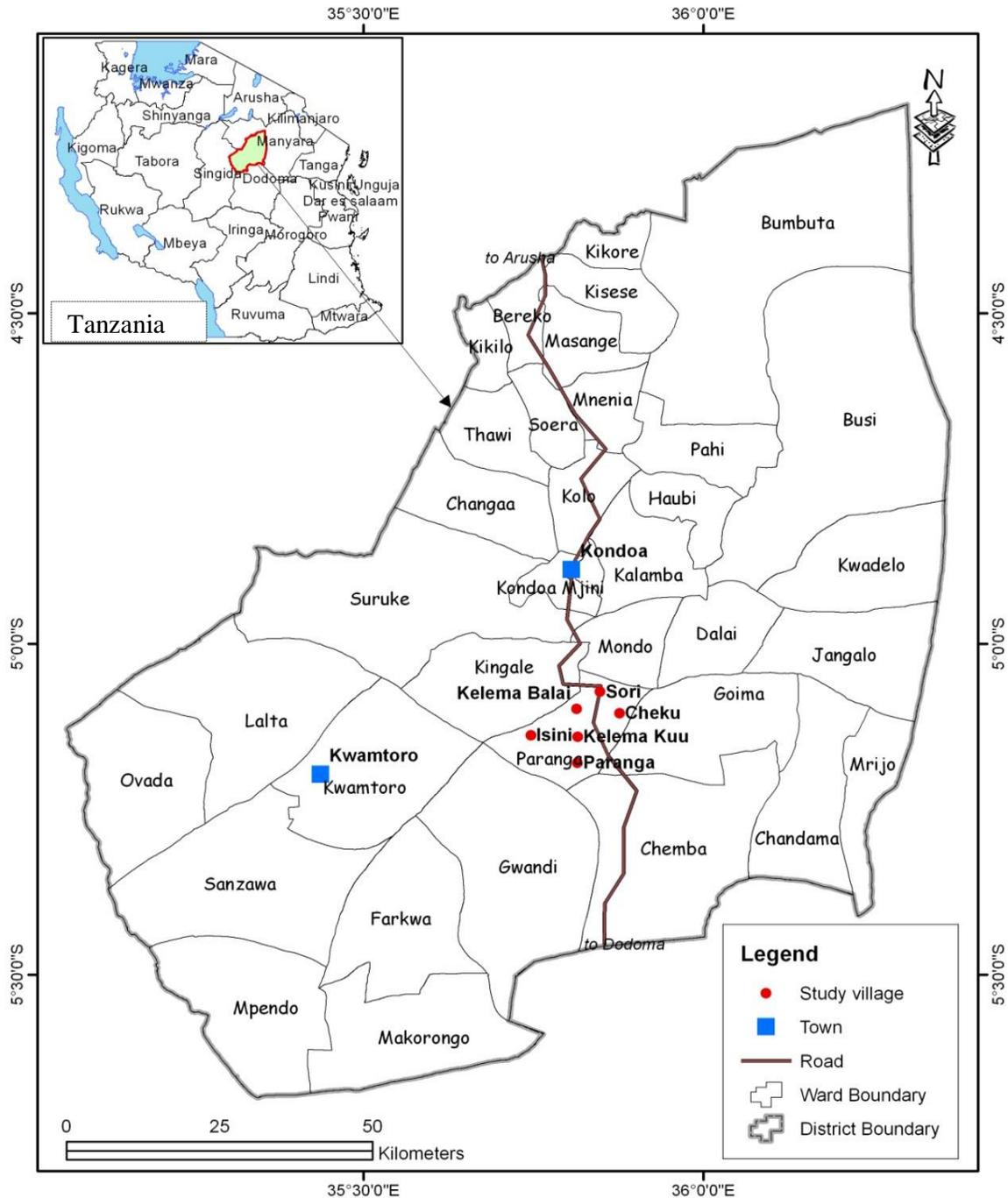
Chi-square tests and binary logistic regression analyses were applied to test the differences between the dependent, as well as the independent variables with a significance level of  $p < 0.05$ . Almost all of the data were non-parametric. Thus, most of the analyses were performed using non-parametric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

The Pearson's  $\chi^2$  tests 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 Kondoa people towards the red-billed Quelea as dependent variables. Data analyses were performed using SPSS (the Statistical Package for Social Sciences, Version 20).

## RESULTS

### Demographic characteristics of respondents

The general characteristics of 360 respondents who were selected from households in six villages within Kondoa District were; 53.6% males and 46.4% females, 37.2% were 18 - 36 years, 40.3% were 37 - 54 years and 22.5%



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

were above 55 years. Two third (70%) of the residents had primary school education, while 17.2% were illiterate and 12.8 had higher education.

Finally, 90.8% were subsistence farmers while 9.2% were involved in local business. Responses from all respondents did not differ significantly between study villages despite of being asked several questions during the interviews.

**Abundance of Quelea**

The abundance of Quelea was assessed by asking people whether the number of harvested birds was increasing or decreasing. Of all 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. Among the respon-

dents who claimed that the *Quelea* populations were increasing (N = 247), 40.6% claimed that it was due to their fecundity, 31.9% claimed that it was due to increased food availability in recent years as a result of increased human population and expansion of cereal crops cultivation and 27.5% claimed that it was due to both breeding efficiency and food availability. Of those who claimed that *Quelea* populations were decreasing (N = 113), 73.5% claimed the decrease was due to spraying of chemicals. Of these, 49.4% claimed that the decrease was both due to over-harvesting, as well as the spraying of chemicals.

### Harvest of *Quelea*

The majority of respondents (97.5%, N = 360) reported that the red-billed *Quelea* were harvested in their areas. 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) were mostly used than fishing nets (36.8%, N = 351).

### Utilisation of the harvested birds

Almost all (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) claimed that the birds were sold as snacks (fried) or fresh meat.

### Positive attitudes

The red-billed *Queleas* were mostly 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 ( $\chi^2 = 62.4$ , df = 1,  $P < 0.001$ ). 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 statement ( $\chi^2 = 38.5$ , df = 1,  $P < 0.001$ ).

The majority (86.7%, N = 256) of respondents who agreed that *Quelea* 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 ( $\chi^2 = 145.6$ , df = 1,  $P < 0.001$ ). 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 crea-

tures, whereas only 26% (N = 104) of those who claimed that *Quelea* has no economic benefits agreed with this notion ( $\chi^2 = 123.5$ , df = 1,  $P < 0.001$ ).

### Negative attitudes

The majority of respondents (97.5%, N = 360) regarded the *Quelea* as pests and (80%, N = 360) reported that *Quelea* birds were the biggest pest problem in the area. Almost all respondents (97.5%, N = 360) claimed that crop damage affected their livelihoods. Furthermore, 96.9% (N = 360) claimed to have experienced crop depredation, of which 71.1% attributed their crop losses to *Quelea* birds. Among the 96.9% who claimed to have experienced crop depredation, 97.7% (N = 343) regarded the *Quelea*'s as pests ( $\chi^2 = 28.6$ , df = 1,  $P < 0.001$ ). However, among the respondents who regarded the *Quelea*'s as pests (97.5%, N = 360), no significant difference was realized between those 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,  $P = 0.774$ ).

### Strategies used to prevent crop depredation

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%).

### Influence of socio-economic factors to human attitudes

The most important socio-economic factors influencing positive attitudes of the respondents were gender and education (Table 1). Men exhibited more positive attitudes than women (Table 1).

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. Fewer respondents with no formal education (61.3%, N = 62) or with higher education (47.8%, N = 46) agreed (Table 1). There was no difference in the interactions between sex and education (Wald = 9.29, df = 5,  $P = 0.098$ , Table 1). However, there was an interaction between sex and education for both positive questions (Wald = 8.5, df = 5,  $P = 0.004$  and Wald = 8.32, df = 5,  $P = 0.004$ , respectively, Table 1). In contrast, the overall statistics of a binary logistic regression analysis was significant only for the question presented in Table 1

**Table 1.** Positive attitudes of people in relation to socio-economic characteristics as a response to the questions, "Do you like Quelea birds?", "Do you like Quelea because of its benefits?", "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 sex\*education as independent variable (N = 360).

Category	Indicator	Percentage agreed question 1	Percentage agreed question 2	Percentage agreed question 3	Binary logistic regression analysis					
					Wald 1	P	Wald 2	P	Wald 3	P
Sex	Males	74.1	68.9	74.6	7.6	0.006	6.13	0.01	6.955	0.008
	Females	60.5	56.3	61.7						
Age	18-36 years	70.1	64.2	68.7	0.001	0.991	0.04	0.84	0.009	0.924
	37-54 years	63.4	60.0	69.0						
	>55 years	71.6	66.7	67.9						
Education level	Illiterate	69.4	61.3	64.5	1.13	0.287	1.4	0.24	0.685	0.408
	Primary school	69.0	66.3	69.0						
	Higher education	58.7	47.8	71.7						
Economic activity	Subsistence farming	68.8	63.6	68.5	1.73	0.188	0.46	0.49	0.02	0.888
	Local business	57.6	57.6	69.7						

(Wald = 11.57, df = 5, P = 0.041). The remaining demographic variables of age and economic activity had no significant influence on positive attitudes (Table 1).

### Negative attitudes in relation to socio-economic factors

Gender, education and economic activity influenced negative attitudes, whereas age did not (Table 2). Most of the respondents (98.8%, N = 252) with primary education regarded Queleas as pests (Table 2), 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 2). Based on the main economic activities, inhabitants whose major economic activity was farming (98.5%, N = 327) regarded the Quelea as pests (Table 2), and in another question, 81.7% (N = 327) of these people agreed that it is the biggest pest problem in the area (Table 2).

Gender elicited an influence on the negative attitudes because a higher 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 2). A binary logistic regression analysis using the three questions in Table 2 as dependent variables and the four demographic variables, as well as the interactions between sex and education as independent variables were significant for each question (Tables 2). In contrast, the interaction between sex and education was significant

only for the question "Do you agree that Quelea is the biggest pest problem?" (Wald = 5.91, df = 5, P = 0.041).

## DISCUSSION

### Demographic characteristics of respondents

The general characteristics of the respondents listed in Table 1 reflect their influence on human attitudes toward the red-billed Quelea. 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. The majority of the respondents were subsistence farmers.

### General management of the red-billed Quelea

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).

**Table 2.** Negative attitudes of people in relation to socio-economic characteristics as a response to the questions, "Do you regard Quelea as a pest?", "Do you agree that Quelea is the biggest pest problem?", "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).

Category	Indicator	Percentage agreed question 1	Percentage agreed question 2	Percentage agreed question 3	Binary logistic regression analysis					
					Wald 1	P	Wald 2	P	Wald 3	P
Sex	Males	97.4	81.3	43.0	0.014	0.906	0.472	0.49	10.20	0.001
	Females	97.6	78.4	59.9						
	18-36 years	96.3	75.4	48.5	0.556	0.456	3.263	0.07	0.001	0.994
Age	37-54 years	98.6	81.4	55.2	0.001	0.991	6.061	0.01	0.001	0.979
	>55 years	97.5	85.2	46.9						
	Illiterate	96.8	85.5	46.8						
	Primary school	98.8	81.3	52.8						
Education level	Higher education	91.3	65.2	45.7	1.13	0.287	6.08	0.01	1.03	0.311
	Subsistence farming	98.5	81.7	51.7	13.8	0.001				
	Local business	87.9	63.6	42.4	0.014	0.906	0.472	0.49	10.20	0.001
	Males	97.4	81.3	43.0						
Economic activity	Females	97.6	78.4	59.9	1.73	0.188	3.263	0.07	0.001	0.994
	18-36 years	96.3	75.4	48.5	0.556	0.456				

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 since 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. Therefore, a new practical, economical and high efficiency control measure for the Quelea birds that does not adversely damage the ecosystem or impact the non-targeted species and the environment is needed in the future.

### Abundance of Quelea

Generally, the red-billed Queleas are regarded as the most abundant wild birds in the world and as a IUCN least concern status (IUCN, 2012). In this study the abundance was assessed by asking the inhabitants whether the number of harvested birds were 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. 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 but harvesting can turn to be more destructive if all households in the district will engage in catching and consuming the birds beyond sustainable level. Most respondents perceived the Quelea populations as significantly abundant because their numbers have been increasing particularly during the wet season. High fecundity, followed by increased food availability, was claimed as the major reason for the enormous Quelea populations in Kondoa. Similar reasons have also been reported by others under ecological studies for Quelea abundance (Cheke, 2003; Cheke et al., 2007; Dallimer and Jones, 2002; Elliott, 2006; Venn et al., 2003).

### Harvest of Quelea

Most of the respondents reported that the Quelea birds were harvested in their areas during both seasons of the year but mostly during the dry season (July to October). 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 and

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 birds

Harvested *Quelea* birds were mostly used as food within households whereas some were sold to passengers at bus stops or to other households within the area. 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 Kondo, where shortages of water and green pastures are common during dry season.

### Positive attitudes

The red-billed *Quelea* was perceived as good and accepted by local people because of its values to humans. This supports our 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 households. Very few people exhibited positive attitudes that were not associated with benefits. 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.

### Negative attitudes

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 Kondo, 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 and Røskoft, 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. 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. This observation supports the second hypothesis that negative attitudes are highly influenced by *Quelea*-related costs.

### Strategies used to prevent crop depredation

All of the control measures for *Quelea* are categorised into the following two main types; scientific and traditional measures. 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 and Giles, 1997; Ruelle and Bruggers 1982). In spite of being tedious and time-consuming, bird scaring was predominantly used by local inhabitants of Kondo 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 and Bruggers, 1982). Despite all the facts, the scaring strategy was observed to have little impact on the alleviation of *Quelea* pest problem (Allan, 1996; Garanito et al., 2000).

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 Kondo have perceived it as the most effective method simply because it kills larger numbers of *Queleas* within a shorter period of operational time. The fact that the people of Kondo did not incur any chemical control economical 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 that can pollute the environment and damage the ecosystem.

The harvesting method has also been used by some people in Kondo to control *Quelea* pest problem. It was also performed as a way to amass *Quelea* birds as food for households, as well as a business for generating income through selling of the harvested 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). 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.

### Influence of socio-economic factors to 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 both positive and negative attitudes were gender and education, while economic activities only influenced the negative attitudes. The men, who were more involved in the Quelea business, received more benefits than women, who were less involved. 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.

### Conclusion

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. The harvesting of Quelea birds can help to reduce the level of crop damage. 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).

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