Journal of Agriculture and Food Environment
Volume 10(1): 21-27, 2023

Faculty of Agriculture
Delta State University
Abraka, Nigeria

Original Research Article

Mapping the Distribution and Pestiferous Activities of Quelea Birds in Bayelsa State, Nigeria, Using GPS and GIS

[1]Amodu, U.S., *[1,2]Ukar, I.A., [1]Agbu, A.U., [1]Obasi, D.C. and [1]Uchua, K.A.

[1]Advanced Space Technology Applications Laboratory
Uyo, Akwa Ibom State, Nigeria

[2]Michael Okpara University of Agriculture
Umudike, Abia State, Nigeria

*Corresponding author: ukarifeanyichukwu@gmail.com; +2347036258982

Received 29th January 2023; Accepted 22nd February, 2023; Corrected 9th March, 2023

Abstract

The red-billed Quelea is the most important avian pest of small grain crops in the semi-arid regions of Africa, with rice being one of the most affected crops. The invasion of some farms by Quelea birds, especially in states like Bayelsa which are predominantly rice producers, has been turned out to be one of the factors responsible for food shortages. Several research efforts have been made to study the behaviour, distribution and activities of crop pests in relation to the extent of damage to agricultural produce, caused by these organisms. Space technologies such as the Global Positioning System (GPS) and Geographical Information System (GIS) technologies have been identified as useful tools in crop pest and disease survey. This study was conducted to evaluate the distribution and pestiferous activities of Quelea bird is Bayelsa state, Nigeria, using a space-based approach. A field survey was conducted and the Latitude (X) and longitude(Y) Coordinates of identified breeding sites of Quelea birds were taken using a hand-held GPS device. The data obtained were digitized using a GIS application tool and used to produce maps showing the spatial distribution of the colonies of the birds across the study area. A total of 13 breeding sites were identified in this study, cutting across Yenagoa, Ogbia, Kolokuma, and Nembe Local Government Areas. Ogbia LGA was observed to have the highest number of breeding sites of the Quelea birds implying that cereal farms in the area were more susceptible to severe damage from Quelea attacks. In this research, space-based technologies have proven to be useful in Quelea bird studies.

Keywords: GPS, GIS, Colonies, Breeding site, Space Technology

Introduction

Food security and the attainment of self-sufficiency in food production are among the cardinal objectives of farmers and the government of every nation. The term *Food Security* refers to the ability to supply adequate food, in terms of quality and quantity to humans to sustain a

productive and healthy life (World Bank, 2021). Loss of farm produce resulting from debilitating activities of plant pests and parasites is a major threat to global and national food security.

Over 70% of people in Nigeria living in rural areas rely on agriculture for their income (Onumadu, 2014). Crop pests constitute a severe challenge and are a major cause of crop damage, poor yield and financial losses to farmers in Nigeria. The red-billed Quelea is the most important avian pest of small grain crops in the semi-Arid regions of Africa, with rice being one of the most affected crops. Gbenga (2017) noted that the invasion of some farms by Quelea birds, especially in states like Bayelsa that are predominantly rice producers, has been avowed to be one of the factors responsible for food shortage. Quelea birds are among the most abundant and destructive birds in the world, causing $US70 million damage to grain crops per annum (Markula *et al*., 2016). They are dangerous parasites and are capable of wiping out everything in the farm within hours or days after invasion (Gbenga, 2017).

Availability of accurate geospatial information on the activities and spread of a given pest is a panacea for its effective management and control. Dminić *et al.* (2010) noted that sufficient information about the ecology of a given pest, particularly concerning their spatial distribution and factors the influence their spatial distribution is necessary for effective pest management.

The application of space-based technologies like Geographical Information System (GIS) and Global Positioning System (GPS) in the area of pest management are advancing today, where activities are conducted over large geographical areas (Faust, 2008; Sciarretta and Trematerra, 2014). According to Sabtu *et al*. (2018) satellite tools such as GPS and GIS have been employed in the collection, mapping, and analysis of the distribution of crop pests and diseases. GPS and GIS are currently being used for various applications in precision agriculture (and Guo, 2017). Spatial analysis is of great importance in integrated pest and disease management. These satellite tools provide useful information about pest populations, the damage, habitats, and potential breeding sites in a given area (Kelly and Guo, 2017). GIS has the capability for tracking, analysing and predicting possible areas for pests (Dminić *et al*., 2010). Deleon *et al*. (2017) reported that GIS was used to produce pest monitoring maps for South Texas cotton and sorghum land managers. The functionality of GIS in several studies on birds has been acknowledged (Faust, 2008; Sciarretta and Trematerra, 2014; Kelly and Guo 2017). In another study conducted in Botswana, Basuti and Dimane (2019) observed that GIS was effective in the management of Quelea data by selection and viewing of data in a variety of ways and manipulation of Quelea data to produce new information through the integration of data sets.

These technologies have advanced in the last few years; they combine real-time data collection with accurate position information, enabling the efficient manipulation and analysis of large amounts of geospatial data. Geographical Information System is a computer tool used to store, access, manipulate, analyse and display spatial information (Dminić *et al.* 2010; Trimble, 2016). GIS has triggered the rapid development of technologies that offer new opportunities and potentially more effective methods for detecting and monitoring bird pests. The use of GIS and GPS for bird distribution mapping and analysis has shown that GIS as a tool can assist in the monitoring of Quelea birds. It is an ideal method for mapping and analysing Quelea birds' data.

In this study, Geographical Information System (GIS) and Global Positioning System (GPS) were employed in mapping the breeding sites and distribution of Quelea birds in Bayelsa state, Nigeria.

Materials and Methods

A Global Positioning System (GPS) device was used to take coordinates of the identified breeding sites of the Quelea birds. GIS was employed for the integration of all data obtained and then subjected to further analysis to produce the final result. The GIS software used for the analysis was ArcGIS 10.5.

The data that was used to map the distribution of Quelea and their habitat were collected from fieldwork and orthophotographs for capturing existing land use. These data were integrated into a GIS in the form of geographic data. A fieldwork survey was undertaken to locate Quelea-breeding sites using GPS and undertake site observation including the habitats and vegetation. The coordinates for the birds' site locations were picked around the sites, as nearest to the centre of the area as possible for accuracy.

Field survey and data collection

A fieldwork and ground truthing exercise was conducted in Bayelsa state to survey, evaluate, map-out and collect data in the areas identified as the breeding sites of the Quelea birds. The data, X and Y coordinates of the breeding sites of the birds, were taken using a hand-held GPS device. The attributes data for the study area such as land cover, vegetation type, crop type, and land area covered by the colonies were also recorded. The sites with a history of more than five years in the same area were mapped and assumed to be permanent breeding areas as observed by Basuti and Dimane (2019).

The control point data (X and Y coordinates) of the geographical location of the identified areas of interest were obtained using a hand-held GPS device. The Ground Control Points (GCP) were necessary for georeferencing and spotting the locations of the Quelea birds. Data on the angles and boundaries of the identified sites were also taken and used for mapping and producing a land-use map for the sites.

The geographical position of place on the earth's surface as measured by a GPS device is based on the principle of trilateration from satellites. The relative positions are ascertained mathematically using the geometry of triangles from satellites. The GPS device can ascertain the true location of a given point, having obtained information from more than three satellites based on the principle of triangulation. The degree of accuracy is directly proportional to the number of satellites. That is, the more the number of satellites involved, the more accurate the measurement.

Data capture and analysis

The data obtained from the field survey were digitized and subjected to analysis using the ArcGIS 10.5 software. Results obtained from the analysis were used to produce maps showing the distribution of the breeding sites of the Quelea birds within the study area. Attribute tables containing information about the different sites were generated from the ArcGIS database. Buffer zones were created on Quelea breeding sites to show areas prone to the damage.

A buffer zone of 5km was created to indicate the spatial distance of crops within the breeding colony sites which are susceptible to serious damage. The data was analyzed using GIS Overlay

analysis tools. An Overlay is a spatial operation tool that overlays two or more polygons, points, or lines to create a new output map. The maps were overlaid to produce a single map showing the distribution of the Quelea birds and their habitats.

Results and Discussion

In this research, a total of 13 colonies were identified and mapped as breeding sites of the Quelea birds across the study area. The coordinates (Latitude and Longitude) of the identified habitats were taken at the centre of the breeding area to ensure that the accurate position of each location was determined. The coordinates and the locations of the colonies across the Local government areas are presented in Table 1.

Table 1: Breeding sites of Quelea bird in Bayelsa State

S/N	Latitude (X)	Longitude (Y)	Location	LGA
1	5^0 2'35.0"	6^0 24'33.9"	Igbogene	Yenagoa
2	4^0 59'59.4"	6^0 15'40.8"	Ikoli bridge	Yenagoa
3	5^0 7'33.8"	$6^0$18'29.1"	Kaima	Kolokuma
4	4^0 53'15.1"	$6^0$19'2.9"	Bayelsa Oil palm Plantation	Ogbia
5	4^0 51'40.1"	$6^0$21'14.5"	Failed Bridge at Imiringi	Ogbia
6	4^0 51'32.9"	$6^0$20'38"	Elebele Failed Bridge	Ogbia
7	4^0 40'9.6"	$6^0$18'49.0"	River Oloibiri	Ogbia
8	4^0 41'20.2"	$6^0$18'45.6"	LNG Landing Jetty	Ogbia
9	4^0 56'4.6"	$6^0$25'8.0"	Oil bunkering site	Ogbia
10	$4^0$41'33.2"	$6^0$19'36.8"	Wood Lumbering Depot Oloibiri	Ogbia
11	$4^0$55'13"	$6^0$24'31.5"	Otuasega Palm and Ogbono Plantation (point 1)	Ogbia
12	$4^0$56'4.6"	$6^0$25'8"	Otuasega Palm and Ogbono Plantation (point 2)	Ogbia
13	4^0 32'18.0"'	$6^0$24'35.1"	Basambily jetty	Nembe

Results obtained from the study (Table 1) show that Ogbia Local Government area had highest number of breeding sites for the crop pest. Nine (9) out of thirteen (13) colonies identified during this study were in located in Ogbia Local Area. The outcome of this study suggests that the crop output, especially the cereal crops which are the primary target of the crop pest, may be greatly affected, as the area will be more susceptible to serious damage by the Quelea birds. The predominance of Quelea colonies in Ogbia suggests that there may be more varieties of plants or crops suitable for food and building their nests in the locality, than other areas have. Oil Palm trees provide a conducive nesting environment for birds. The majority of the palm plantations identified in this study were situated in Ogbia local Government. Basuti and Dimane (2019) in a similar study, reported that Quelea breeding sites were prevalent in areas where there were shrubs like Acacia. The acacia trees are shrubs with heights of approximately 3m. These trees are preferred by Quelea birds for building their nests because the trees have small thorny branches that are close together and have spaces that can be used by the birds to build a nest that cannot be destroyed easily by winds and heavy storms. Quelea colonies identified during the field survey in this study, were mainly in areas with palm trees, as most of their nests were constructed on palm branches. Palm trees are potential habitats for birds as their features are favourable for making nests.

Figures I and II, show the spatial distribution of the Quelea birds in the study area. Land cover is important for showing the distribution of vegetation and Quelea habitats; the distribution of the

preferred grasses and vegetation within the Quelea range provides information about areas where Quelea may establish their breeding colonies (Basuti and Dimane, 2019). The map reveals that the birds had their colonies in areas closer to human settlements. This could be attributed to the availability of vegetation and food materials within the environment due to human activities such as crop farming.

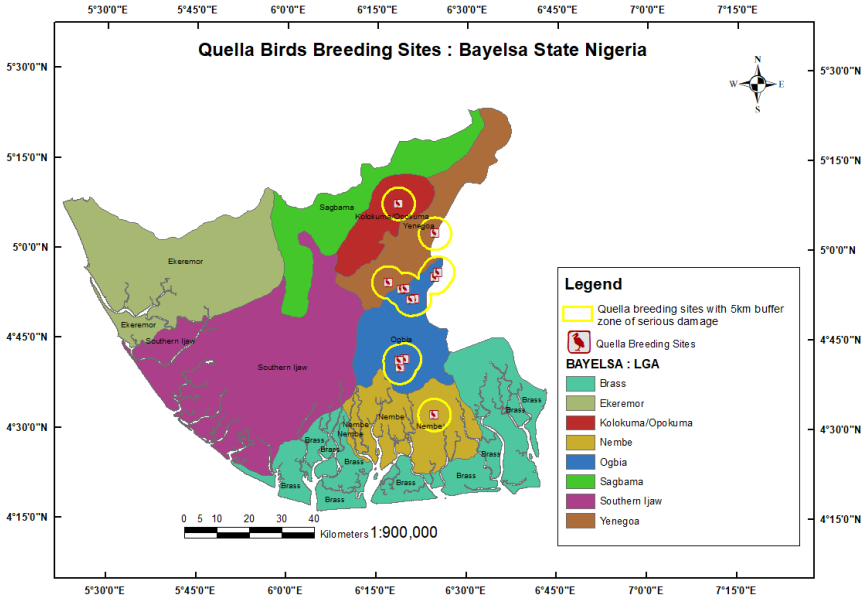

Figure 1: Map showing the spatial distribution of Quelea birds in Bayelsa

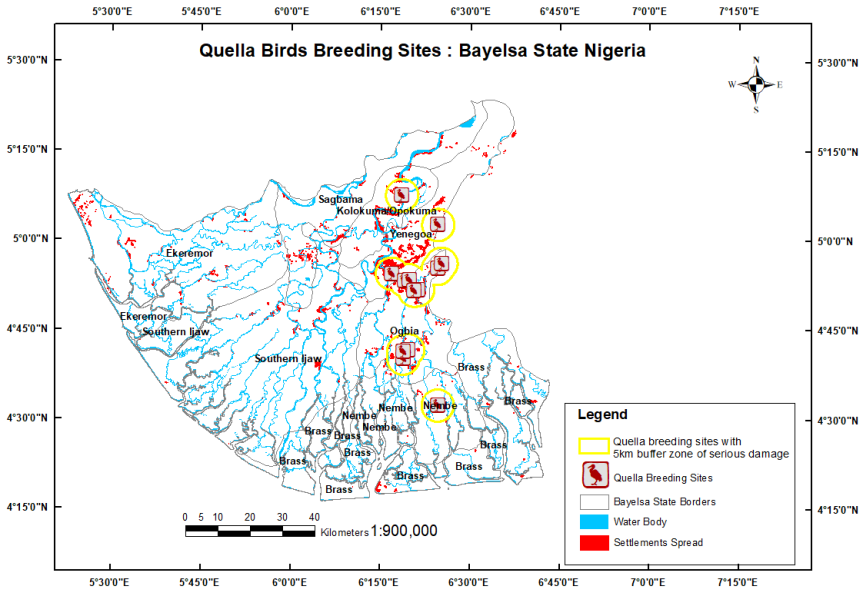

Figure 2: Map showing water bodies, settlements and Quelea birds distribution in Bayelsa

The spatial distribution of the birds, water bodies, and settlement in the study area is presented in Figure 2. Availability of water and food is a major factor influencing the distribution of the crop pest in an area. Quelea birds drink water in the morning and evening hours, therefore their habitats are expected to be found near water bodies. Basuti and Dimane (2019), in a study, observed that water sources, mainly rivers were responsible for the establishment of Quelea bird colonies in the area. The presence of water bodies in and around the study area is a key factor responsible for the establishment of breeding sites.

Conclusion

Space technology has been identified as a veritable tool for scientific research and exploration. The distribution of Quelea birds in Bayelsa state was successfully mapped and digitized using a Space-based approach. GPS and GIS applications have been proven to be viable tools for mapping and analyzing the spatial distribution of Quelea birds. The actual positions/locations of the breeding sites of these crop pests, as well as factors that influence the choice of such locations, have been studied using GPS and GIS tools. The map produced from the digitization of the Coordinates obtained using the GPS clearly shows the spread of the breeding sites of the Quelea birds across the study area. The result of the study will provide useful information that could aid decision-making and effective planning of crop protection strategies, targeted towards promoting food security in Nigeria.

References

Basuti, B. and Dimane, M. (2019). Mapping of Crop Birds Pest using GPS and GIS. *Journal of Agricultural Informatics* 10(1): 12-20.

Deleon, L., Brewer, M.J., Isaac, L., Esquivel, I.L. and Halcomb, J. (2017). Use of a geographic information system to produce pest-monitoring maps for south Texas cotton and sorghum land managers. *Crop Protection* 101: 50-57. http://dx.doi.org/10.1016/j.cropro.2017.07.016.

Dminić, I., Kozina, A., Bažok, R. and Barčić, J.I. (2010). Geographic information systems (GIS) and entomological research: A review. *Journal of Food, Agriculture and Environment* 8(2): 1193-1198.

Faust, R.M. (2008). General introduction to Area-wide pest management. In: Koul, O., Cuperus, G. and Elliott, N. (Eds.): *Area-wide Pest Management. Theory and Implementation*. CAB International, Wallingford: pp. 1–14.

Gbenga, A. (2017). Combating the Menace of Quelea Birds. The Guardian News Paper. 08 October, 2017. P. 16.

Kelly, M. and Guo, Q. (2017). Integrated Agricultural Pest Management through remote sensing and spatial analyses. In. Ciancio, A. and Mukerji, K.G. (Eds.). *General Concepts in Integrated Pest and Disease Management*. Springer Nature, Hanover, Pennsylvania, Pp. 191-207. https://doi.org/10.1007/978-1-4020-6061-87

Markula, A., Jones, M.H. and Csurhes, S.C. (2016). *Red-Billed Quelea*. First published 2009, Updated 2016. https://www.daf.qld.gov.au/_data/assets/pdf_file/0011/57845/IPA-Red-Billed-Quelea-Risk-Assessment.pdf

Onumadu, F.N., Ekwugha, G.N. and Osahon, E.E. (2014). Resource use efficiency in arable crop production in Oyi Local Government Area, Anambra State, Nigeria. *International Journal of Scientific and Technology Research* 3(1): JANUARY 2014. ISSN 2277-8616. Pp 230235.

Sabtu, N.M., Idris, N.H. and Ishak, M.H.I. (2018). The role of geospatial in plant pests and diseases: an overview. IOP Conference Series: *Earth and Environmental Science* 169 012013 https://doi.org/10.1088/1755-1315/169/1/012013

Sciarretta, A. and Trematerra, P. (2014). Geostatistical tools for the study of insect spatial distribution: Practical implications in the integrated management of orchard and vineyard pests. *Plant Protection Science* 50(2): 97-110 https://doi.org/10.17221/40/2013-PPS

Trimble (2016). Mapping & GIS: handheld computers with GNSS http://www.trimble.com/mappingGIS/Handheld-Computers-GNSS.aspx. on December 30, 2016

World Bank (2021). *What is Food Security?* World Food Summit. www.worldbank.org