

## Reclamation of mosquito breeding sites using Landsat-8 remote sensing data: A case study of Birnin Kebbi, Nigeria

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### Abstract

It is believed by recent releases of World Health Organization (WHO) that more than half of the world's population (3.2 billion) live in areas that are at risk of malaria transmission. Although increased efforts are dramatically reducing the malaria burden in some places where the rate of new cases indicates a fall by 37% globally and 60% death rate. Unfortunately, the sub-Saharan Africa still shares 89 % of malaria and 91% of malaria deaths. Essentially, attacking the causative vectors and reclamation of the vector breeding sites could be remarkable for the rolling back the malaria epidemic project. Consequently, it is essential to explore the possibility of using recent Landsat-8 data remote sensing data and applications of Geographic Information System (GIS) technique in contributing to the realization of this objective. This investigation used for identifying mosquito breeding habitat (Derelict Ponds) zones the application of supervised classification of the Landsat-8 image in conjunction with GIS layering which allowed identification of high risk prone regions for mosquito breeding habitat. The methodology delineated 10 spatial locations of the Derelict Ponds (DP) spread around the Birnin Kebbi urban environment. Moreover, the results combined with comparative analysis of the link between warm climatic (temperature and rainfall data) conditions and Malaria prevalence that is associated with urban poverty. This study indicates that the application of Landsat-8 data and GIS techniques can be a useful tool for planning and management of environmental health and mapping of hot spot environmental problem areas.

### 1. Introduction

Rolling back Malaria from the depressed ground surfaces that emanated from human activities such as earth mining in the Birnin Kebbi environment. The capital of Kebbi state is not to neglect the pre-imaginable mosquito habitats existing and facing treatment or curative measures only but to find the interface between the host and the vectors (Derelict Ponds). This should form a critical audit of the environment by quantifying the applicability of preventive and the curative control measures. These ponds fill with water during rainy seasons bringing to people high cases of plasmodium falciparum within periods of time. It is

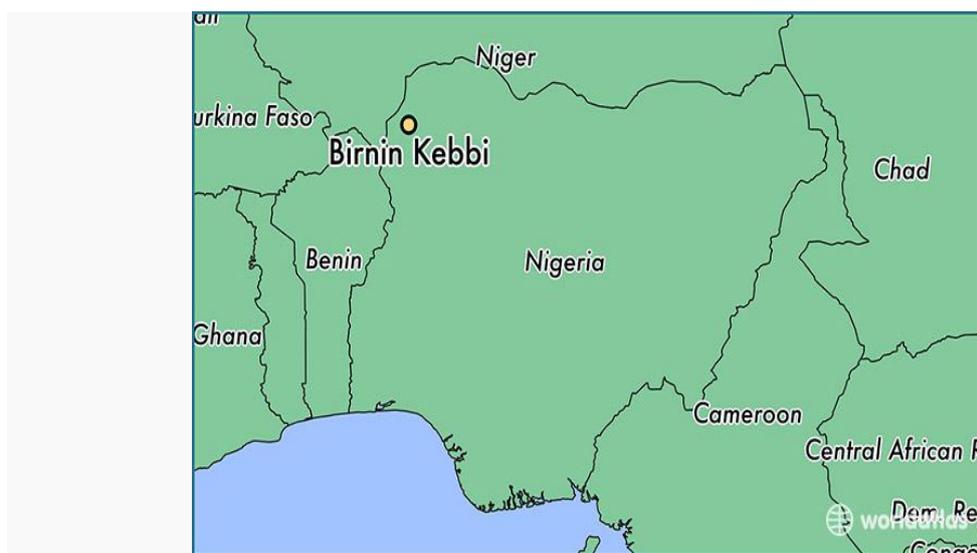
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one of the major medical challenges in the region. The medical centres within the urban environment records high percentage of malaria cases annually especially during the rainy seasons that occur between the months of June and October (rainy season).

It is evident that the malaria risk is connected to a wide variety of derelict mining ponds that existed in the environment. The mining ponds can be found everywhere in the state, but many of them have been abandoned due to lack of proper planning. Some of them are used as illegal refuse dump sites. The objective of the paper is to use Landsat-8 imagery and GIS techniques to delineate the positions of these mosquito breeding habitats (Derelict Ponds), around the study area and the level of their abandonment whose consequence bring about the malaria incidences.

## 2. Methodology

Birnin Kebbi city is located in north-western Nigeria (Figure 1). It is the capital city of Kebbi State and headquarters of the Gwandu Emirate. As of 2007 the city had an estimated population of 125,594. The geology of Kebbi State is dominated by two formations of the pre Cambrian Basement Complex in the south and south east and young sedimentary rocks in the north. The Basement Complex region is composed of very old volcanic and metamorphic rocks such as granites, schists, gneisses, quartzites and migmatites. In addition, there are meta-sediments such as phyllites and meta-conglomerates. The sedimentary region consists of rocks of the Gwandu, Illo and Rima groups whose ages range from the Cretaceous to the Eocene. The Gwandu group consists of massive clay grits inter-bedded with sandstone while the Illo and Rima groups consist of pebbly grits, sand stones and clays, mudstones and siltstones respectively. Minerals that can be found in the state include quartz, kaolin, potolitic bauxite, clay, and potassium, silica sand and salt [1].



**Figure 1.** Location of Birnin Kebbi city in the north-western Nigeria.

In this study, Landsat-8 data of the north-western Nigeria were used for identification of Derelict Ponds (DP) location. A cloud-free level 1T (terrain corrected) Landsat-8 image were obtained through the U.S. Geological Survey Earth Resources Observation and Science Center (EROS) (<http://earthexplorer.usgs.gov>). It was acquired on May 3, 2014 for the study area. The image map projection is UTM zone 40 North (Polar Stereographic for Antractica) using the WGS-84 datum [2, 3]. Malaria data and GPS ground surveys were also utilized for this investigation. The data acquired for this study is from the annual returns of the Sir Yahaya Memorial Specialist Hospital for the cases of malaria and typhoid fever for a period of nine years (2006 to 2014), which shows the annual number of patients, treated of malaria and typhoid fever (Table 1). GPS ground surveys were carried out at the ten locations of the ponds obtaining the latitude and Longitudes of the ponds where obtained. The areas of these ponds were calculated from the coordinates obtained from the GPS observations.

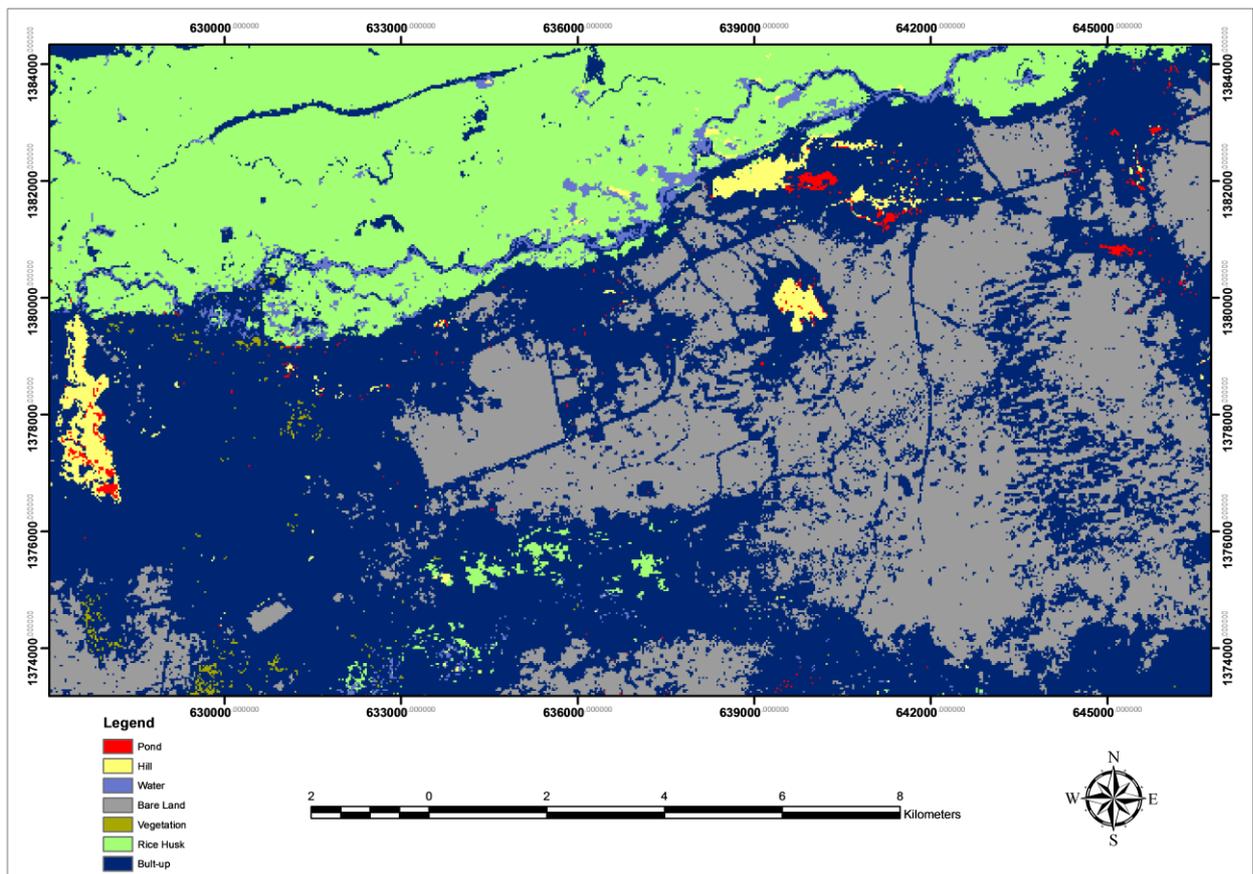
**Table 1:** Malaria and Typhoid cases during 2006 to 2013.

| YEAR | PERIOD  | MALE | FEMALE | DISCHARGE | DEATH |
|------|---------|------|--------|-----------|-------|
| 2006 | Jan-Dec | 191  | 237    | 392       | 36    |
| 2007 | Jan-Dec | 202  | 225    | 383       | 44    |
| 2008 | Jan-Dec | 205  | 234    | 398       | 35    |
| 2009 | Jan-Dec | 181  | 219    | 378       | 32    |
| 2010 | Jan-Dec | 227  | 264    | 447       | 44    |
| 2011 | Jan-Dec | 207  | 238    | 405       | 40    |
| 2012 | Jan-Dec | 199  | 230    | 390       | 48    |
| 2013 | Jan-Dec | 194  | 239    | 387       | 46    |
| 2014 | Jan-Dec | 214  | 251    | 423       | 44    |

This work was carried out using ENVI and ArcGIS environments to derive information about the locations and features of ponds. The Landsat 8 image covering the study area was enhanced in the ENVI environment by contrast stretching method, this method of image processing enable transformation of the multispectral image data into an image display that reveals the background of information of each pixel of the image as well as layer stacking process. The stacked layered image was exported to ArcGIS environment for further processing. The image data was added as input raster into ArcGIS then the RGB combinations was done according to the choices of bands that will enhance the identification of details. The image Supervised classification technique was undertaken and it is a task for extracting information classes from a multi band raster image. The supervised classification procedure was adopted to categorize all pixels in a digital image to be one of the several classes or themes and come up with a thematic map. The spatial pattern within the data for each pixel was used as the numerical basis for categorization [4].

### 3. Result and discussion

Figure 2 shows supervised classified image map for Birnin Kebbi city derived from Landsat-8. Variety of different information was extracted for the study area. Derelict ponds are appeared as red color in north-east, center and western segment of the scene. Most of the derelict ponds are located in residential (build up) areas. However, some of them are associated with hilly areas that appeared as yellow color. Several small derelict ponds were detected in residential area as red pixel especially western part of the image map. Rice husk appears light green color in the north part of the image. Residential (build up) region manifested as dark blue and bare land as gray pixels, which are distributed in central and southern segments of the image. Water body and river are depicted in light mauve hue.



**Figure 2.** Supervised classified image map of Birnin Kebbi city derived from Landsat 8 data.

Table 2 shows the location and size of 10 large derelict ponds in Birnin Kebbi city, which were obtained by GPS ground surveys. The identified derelict ponds using Landsat 8 data were coincided with field survey results.

**Table 2:** Location and size of derelict ponds in the in Birnin Kebbi city.

| S/N | NAME                    | AREA M <sup>2</sup> | RECLAIMED?  | ANY DRAINAGE? |
|-----|-------------------------|---------------------|-------------|---------------|
| 1.  | Tudun Wada Pond         | 251.001             | No          | No            |
| 2.  | Presidential lodge pond | 518.735             | No          | No            |
| 3.  | Rafin Atiku Pond        | 278.890             | Sand filled | Yes           |
| 4.  | Illela Yari Pond        | 348.175             | No          | No            |
| 5.  | New Cemetery Road Pond  | 139.445             | No          | No            |
| 6.  | Ya Yara Market Pond     | 334.668             | No          | No            |
| 7.  | Atiku Villa Pond        | 139.445             | No          | Yes           |
| 8   | Dukku hill pond         | 250.230             | No          | No            |
| 9   | Ambursa pond 1          | 390.460             | No          | No            |
| 10  | Ambursa Pond 2          | 337.120             | NO          | No            |

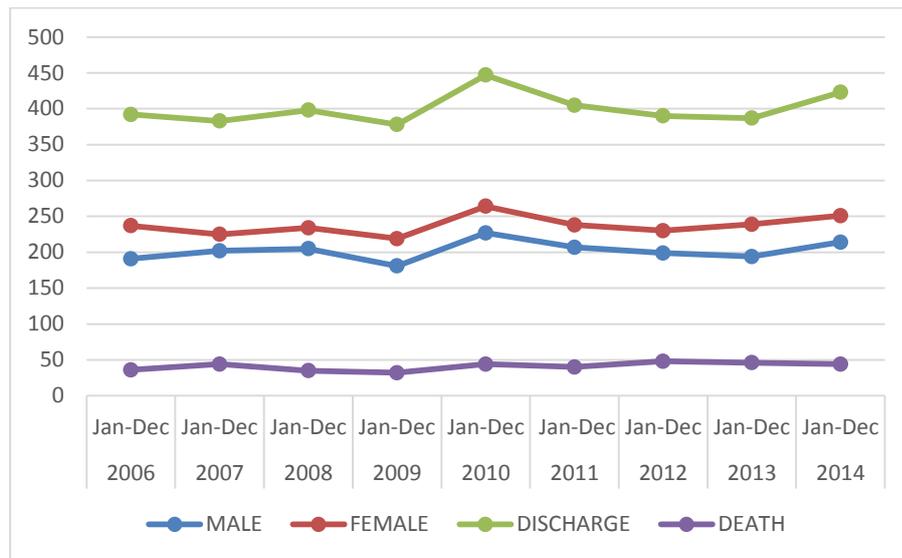
Figure 3 and 4 show derelict ponds, which they filled with vegetation and solid waste dumped, which are suitable place for mosquito habitats. These ponds fill with water during rainy seasons bringing to people high cases of plasmodium falciparum within periods of time. Malaria and Typhoid cases during rainy seasons bloom in residential region around the derelict ponds in Birnin Kebbi city every year [5]. Figure 5 shows the affected population by the Malaria and Typhoid during rainy seasons in 2006 to 2014, which led to death in some cases.



Figure 3: A pond covered by water Lilly.

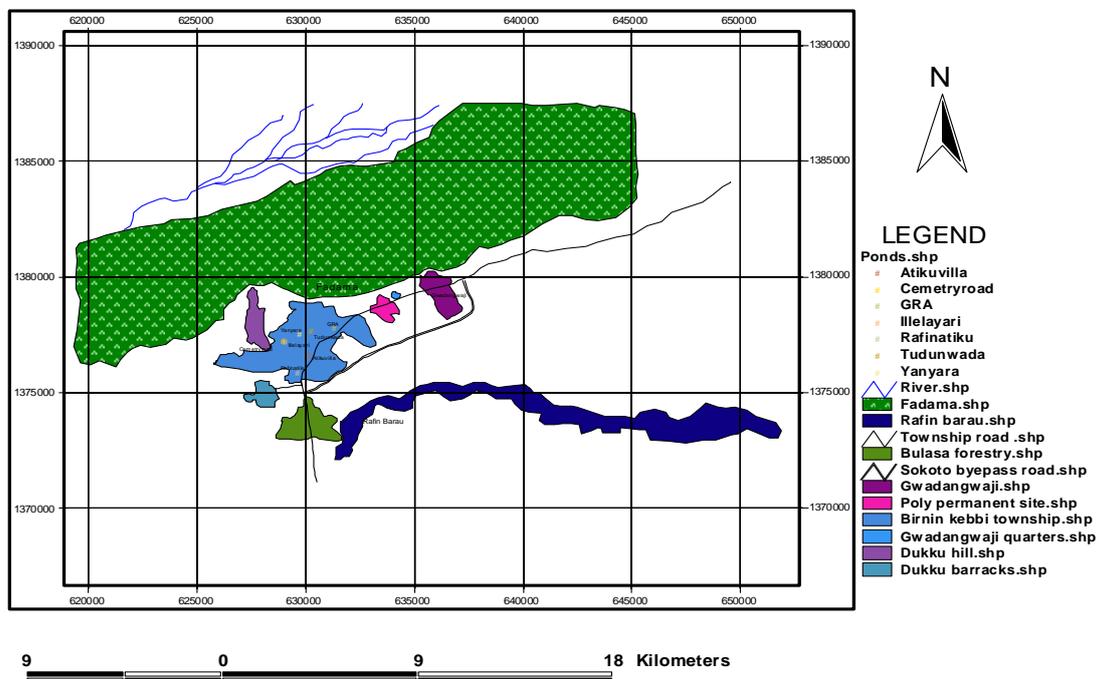


Figure 4. Solid waste dumped in one of the ponds.



**Figure 5.** Malaria and Typhoid cases during rainy seasons in 2006 to 2014 for Birnin Kebbi city.

Land used map has been produced for Birnin Kebbi city using Landsat-8 and GIS techniques (Figure 6). Most of derelict ponds with different sizes and shapes are depicted on the map.



**Figure 6.** Land used map of Birnin Kebbi city.

Although, there is no climatic recording stations in Birnin Kebbi, but the town falls within the Theison polygon whose recording stations is situated at Sokoto. The average maximum temperature ranges between 30<sup>0</sup>c and 41<sup>0</sup>c, while the average minimum ranges between 15<sup>0</sup>c and 26<sup>0</sup>c. Average rainfall is 740mm annually, and spreads over a rainy season of about 120 days (Figure 7). A larger water deficit occurs due to a high potential of evaporation level during the hot season. At these periods, the ponds get filled up with from rain to overflow. The absence of drains to discharge the water away makes some of the derelict ponds to contain water all of the year. These places are suitable for mosquito breeding, which is a continuous exercise throughout the year.

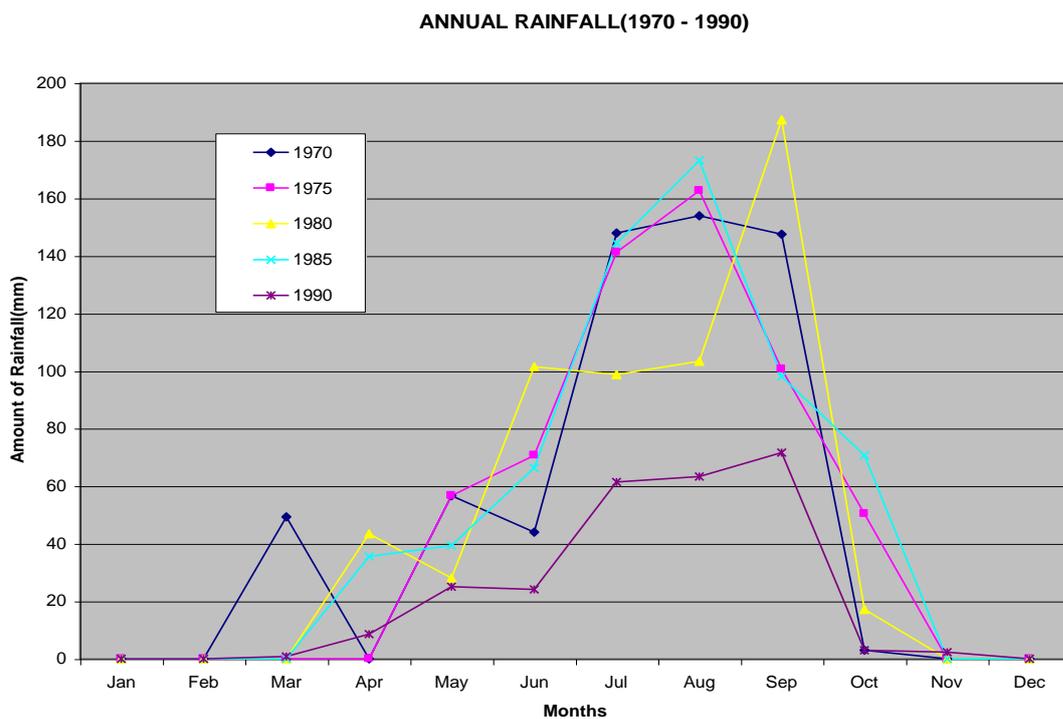


Figure 7. Annual Rainfall variability during 1970 to 1990 for Birnin Kebbi region.

#### 4. Conclusion

Results of this study indicate that the combination of satellite remote sensing data from Landsat-8, GIS techniques and field survey is very useful tool for identification of derelict ponds as mosquito habitats in Birnin Kebbi city. Several problems are associated with derelict ponds, including the occupation of unnecessary space that is not beneficial to citizens except serving as breeding mosquito habitat, reducing the availability of the land that could be consider for the growing population and endangering tourism potentials. Reclamation is the best option to these ponds. The exercise of reclamation is usually aimed at improving water or land resources for agriculture and other purposes through the use of drainage or irrigations, restoration of mine workings and other construction activities. The reclamation work should be started immediately after the mining is completed, through planting of trees and grasses. In this type of procedures lovely forested hills, plains or valleys are the result which later becomes economical to the government since people visit such places as tourism potentials site in Birnin Kebbi city.

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#### References

- [1] Obajea MA 2013. The Sokoto Basin of Northwestern Nigeria: A Preliminary Assessment of the Hydrocarbon. *Petroleum Development Technology Journal*, 3(2).
- [2] Pour AB, Hashim M, 2015. Hydrothermal alteration mapping from Landsat-8 data, Sar Cheshmeh copper mining district, south-eastern Islamic Republic of Iran. *Science Direct Journal* 155-160
- [3] Roy E 2013. Turbid wakes associated with offshore wind turbines observed with Landsat 8. *Remote Sensing of Environment*, 145(2014), 105-115.
- [4] Lillesand TM and Kiefer RW 1994. *Remote Sensing and image interpretation*, third edition. John Wiley & Sons, inc, printed in United States of America.9-12; 531-536;542-562
- [5] Payne N and Hahn S 1995. *Understanding your health* 4<sup>th</sup> edition. Printed in the United States chp 18, pp446 – 475.