# Geospatial Analyses of Mining-Induced Land Degradation Sites in Jos South Local Government Area, Plateau State-Nigeria

by

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# PRESENTATION OUTLINE

- INTRODUCTION
- METHODS
- RESULTS
- DISCUSSION
- CONCLUSION

# INTRODUCTION

- Land as one of the greatest tangible assets
- Degradation as a perceptual term (Piers and Harold, 2015)
- Mining and its subsequent activities causes land degradation (Sahu & Dash, 2011).
- Mining commenced on the Jos Plateau around 1902; Tin & Columbite as the foremost targets minerals (Gyang and Ashano, 2009).
- Abandoned mining ponds, lotto, and pits, as well as heaps of mine waste in the study area resulted in land degradation, etc.
- This study focuses on the geospatial analyses of the geometrical characteristics of mining-induced land degraded areas of the Jos South

# INTRODUCTION

- Jos South LGA total area is 512 km².
- Average altitude is 1280mabove M.S.L.
- Population figures: 407,9500 as at March, 2016
- The mean annual rainfall ranges from 1347.50 to 1460.00 mm in a year (Dawen, 2012).

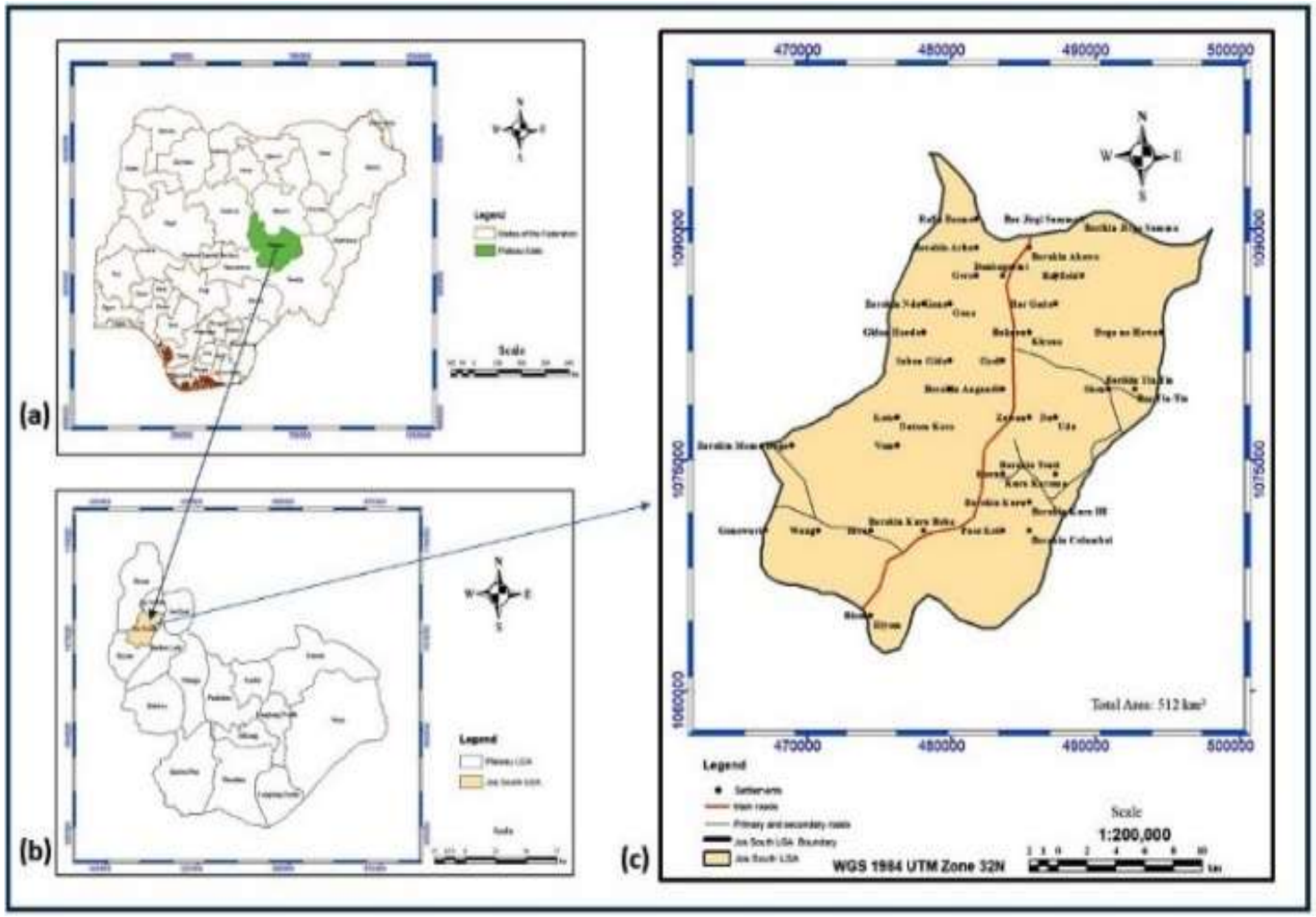


**Figure 1: (a)Nigeria (b)Plateau State (c) Jos South LGA (the study area)**

# INTRODUCTION cont`d



**Plate I:** Active Mining Site at Kuru Janta Mines (10/11/2015)

**Plate II:** Searching for Tin and Columbite at the 'Rayfield' Resort Centre Site (03/06/2015)

**Plate III:** Settlements built at the extreme edge of pond (10/11/2015)

# METHODS

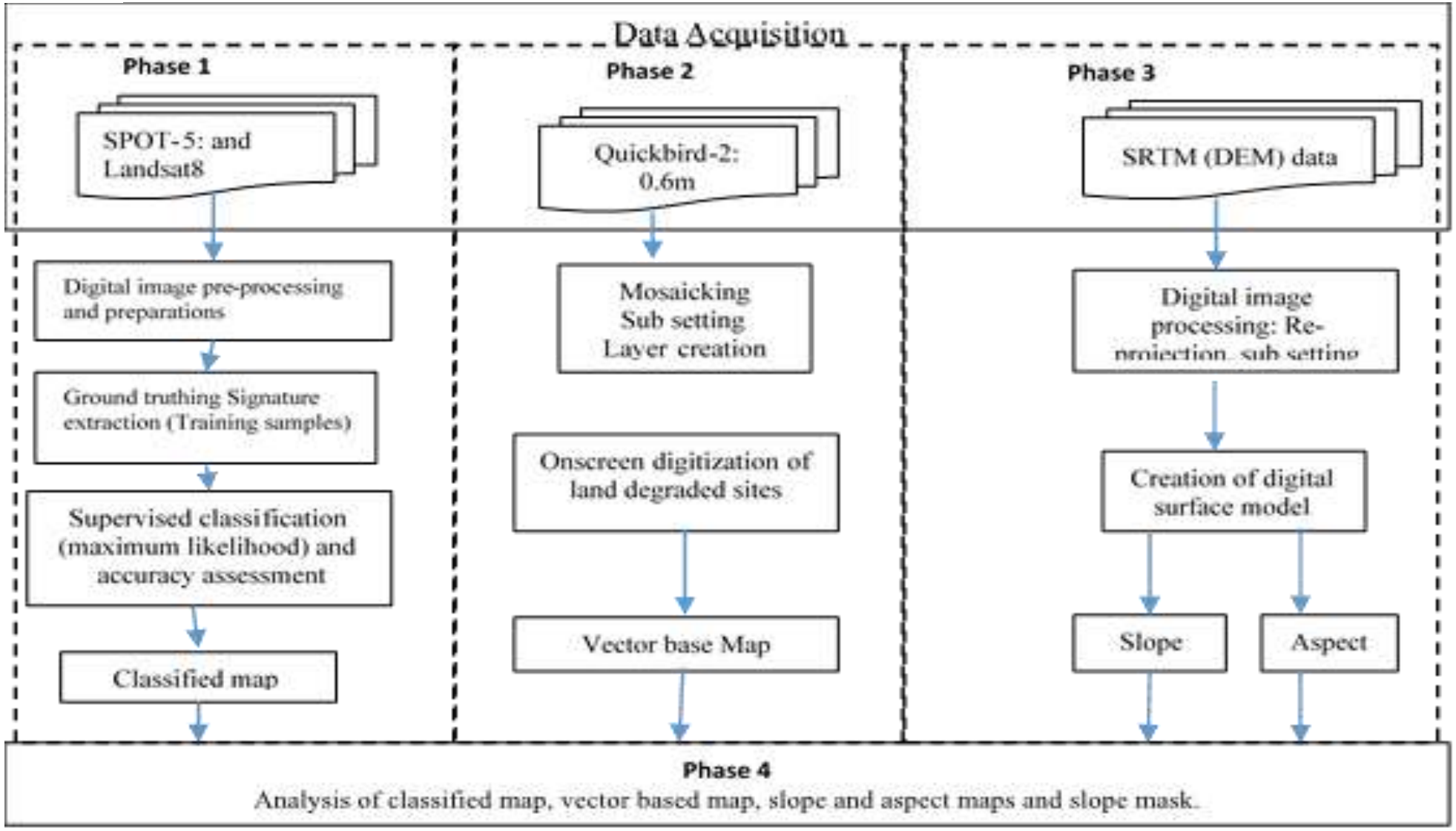


**Figure 2: Methodology workflow diagram (after; Bala, 2018)**

# METHODS cont'd

## Table 1: Datasets and Sources

| Data Name | Resolution | Data Date | Data Source | Purpose | Description |
|---|---|---|---|---|---|
| SPOT 5 | 2.5 m | 7/12/2012 | Office of the Surveyor General of the Federation | Land degradation mapping and analysis | 3 bands multispectral image: NIR, red and green |
| Landsat 8: OLI and TIRS | 15, 30& 100m | 11/2/2016 | http://www.glovis.usgs.gov/ | Collateral data for land degradation mapping | 11 bands multispectral image acquired by OLI and TIRS |
| Quickbird image | 0.6 meters | 2010 | National Centre for Remote Sensing, Jos | Data for polygonising the land degraded sites | 3-band multispectral image: NIR, red and green. |
| Digital Elevation Model (DEM) | 20 m in both H and V directions | - | Office of the Surveyor General of the Federation | Terrain visualization and analysis | A raster Digital Elevation Model (DEM) covering the study area. |
| Jos South admin map (Shapefile) | - | - | National Centre for Remote Sensing, Jos | To demarcate the study area | Jos South local government boundary shapefile |
| Google Earth Pro 7.1.2 2041 imagery | Variable resolution | 2016 | http://www.google.com/earth/download/ge/agree | Ancillary data for land cover mapping | Quick look mono-spectral image displayed over red, green and blue colour gun |

# METHODS cont'd

- **Data Attribute Handling, Encoding and Digitization of Degraded Sites**
  - ✓ heads-up digitizing/ on-screen digitization of the degraded site.

- **Classification of degraded sites based on features**
  - ➢ The Nigeria Erosion and Watershed Management Project (NEWMAP) criteria
  - ➢ Classification based on the functions of the abandoned mining sites
  - ➢ The overall degradation rate:

$$Overall\ Degradation\ Percentage\ = \frac{(Total\ Area\ Degraded)}{(Total\ Area)}\ x100$$

- **Mapping clusters of degraded sites**

# METHODS cont'd



## Land Use Classification in the Neighbourhood of the Degraded Area

**Table 2: A description of the six adopted land classes**

| Training sample | Code | Color assign | Description |
|---|---|---|---|
| Mine pond | 1 | Blue | Land surface occupied by stagnant water body without tributaries which are caused as a result of excavation/mining of earth material e.g. lake |
| Settlement | 2 | Red | Commercial, industrial, residential places, etc. |
| Bare exposed Rocks | 3 | Gray | Land consisting of rocky and stony materials. |
| Farmland | 4 | Lemon | Land occupied or related to agriculture or farming activities. |
| Bare degraded land | 5 | Yellowish | A bare surface that consists of exposed excavated earth surface material with no vegetation. |
| Vegetation | 6 | Light green | Shrubs and other vegetation that is not used for farming activities. |

# METHODS cont'd



**Analyses of Terrain in the Neighbourhood of the Abandoned Mining Sites**

- The DEM data scene was clipped to match the study area (see Figure 3).

- The slope and aspect maps were generated based on Eqn. 1 and 2 (ESRI, 2017b).

$$Percent\ of\ slope = (Rise \div Run) \times 100 \quad (1)$$

$$Degree\ of\ slope, \theta = \tan^{-1}(Rise \div Run) \quad (2)$$

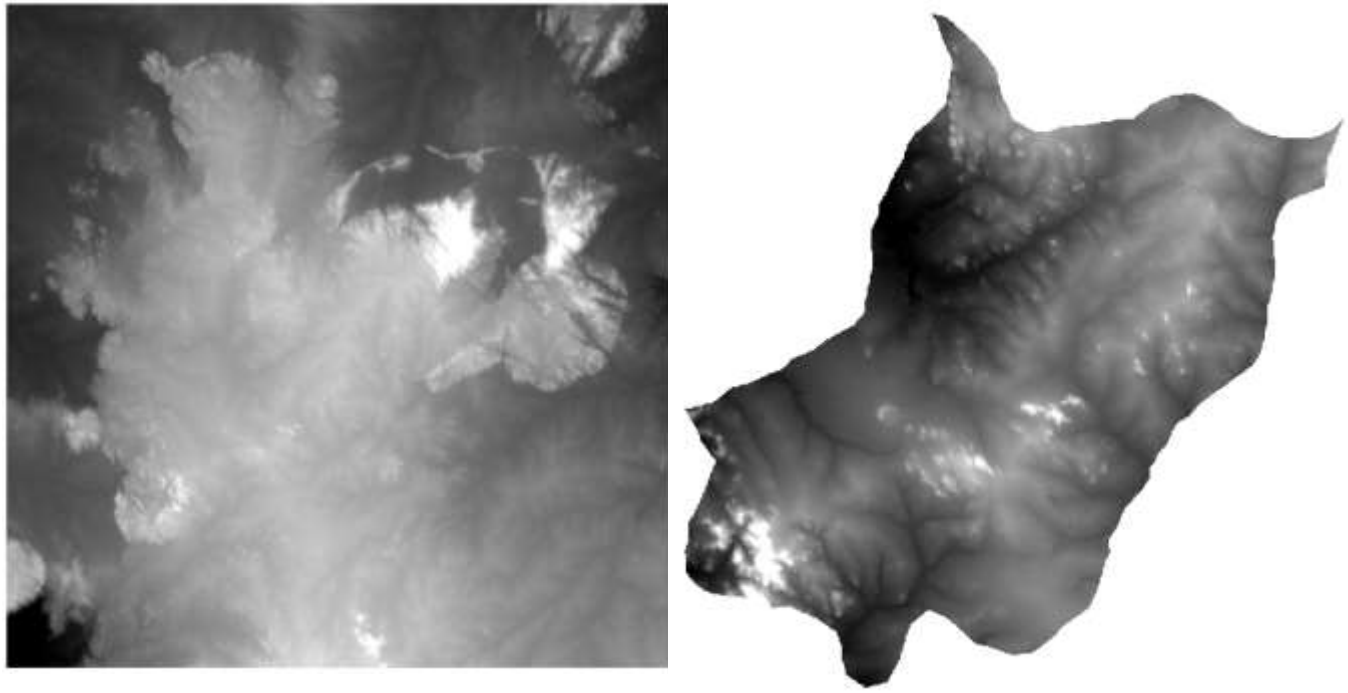

**Figure 3: (a) A DEM scene; Jos South (b) A subset DEM of the study area**

# RESULTS

## Demarcation and delineation of degraded sites



- ✓ A total of 235 mining-induced sites
- ✓ total area of 11.58 km² were delineated and classified based on their functions.
- ✓ Most of the sites were seasonally inundated with various uses.
- ✓ Ten major degraded sites were summarized ( Table 3).

$$Overall\ Degradation\ Percentage = \frac{(\mathbf{2019020.2})}{(\mathbf{11581829.825439})}\ x100 \quad \textbf{=17.43\%}$$

**Table 3: Description of Ten Selected Major Degraded Sites**

| S/ No | Name | Total Area ($km^2$) | Coordinates | Remarks |
|---|---|---|---|---|
| 1 | The Rock and Clay Industry Limited Mines | 0.66 | 9°41'49.12"N; 8°51'30.45"E | Active Illegal mine site |
| 2 | The Healthy Body Clinic site | 0.01 | 9°45'24.10"N; 8°50'38.36"E | Resort centre; Block Industry; seasonal inundation |
| 3 | Rayfield Resort centre | 0.53 | 9°50'24.91"N; 8°55'0.62"E | Resort centre; Illegal Mining |
| 4 | Dorowa Congo site | 0.02 | 9°46'51.12"N; 8°52'25.53"E | Seasonal inundation; used as landfills; settlements built nearby |
| 5 | Zawan site | 0.03 | 9°45'34.33"N; 8°51'51.87"E | Seasonal inundation, threat to life; partially reclaimed |
| 6 | Consolidated Tin Mines Ponds | 0.03 | 9°47'7.47"N; 8°51'38.05"E | Seasonal inundation; partially reclaimed through stone pitching |
| 7 | Jos International Breweries Mines Site | 0.17 | 9°51'37.91"N; 8°54'26.95"E | Water used for block industry; |
| 8 | Yelwa Ponds Sites | 0.05 | 9°48'5.40"N; 8°52'30.25"E | Water treatment plant; block industry |
| 9 | Rahwol Kanang sites | 0.49 | 9°48'14.70"N; 8°54'3.77"E | Irrigation; Fish stocking; farming |
| 10 | Rennaj Fish and Integrated Farm Limited Pond | 0.04 | 9°48'44.22"N; 8°54'20.07"E | Fish stocking; Farming; Source of water |
| | **Total Area** | **2.02** | | |

# RESULTS

## Classification of degraded sites based on features



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**Table 4: Attributes and Features of the Degraded Sites**

| S/No | Classes | Total Area ($km^2$) | Area Degraded (%) | Total number of Sites |
|---|---|---|---|---|
| 1 | Active Mine sites | 1.32 | 11.38 | 9 |
| 2 | Agricultural Usage | 0.74 | 6.35 | 18 |
| 3 | Dormant | 0.78 | 6.76 | 25 |
| 4 | Fencing | 0.38 | 3.31 | 8 |
| 5 | Fish Stocking | 1.17 | 10.14 | 22 |
| 6 | Inundated seasonally | 1.80 | 15.50 | 29 |
| 7 | Irrigation | 1.55 | 13.36 | 50 |
| 8 | Ownership | 0.90 | 7.80 | 11 |
| 9 | Partial inundation | 0.46 | 3.93 | 13 |
| 10 | Resort Centre | 0.67 | 5.77 | 6 |
| 11 | Tree planting | 0.40 | 3.45 | 13 |
| 12 | Waste dumps/Tailings | 0.93 | 8.06 | 21 |
| 13 | Water treatment | 0.49 | 4.19 | 10 |
| | **TOTAL** | 11.58 | 100 | 235 |

# RESULTS

## Mapping clustered degraded sites



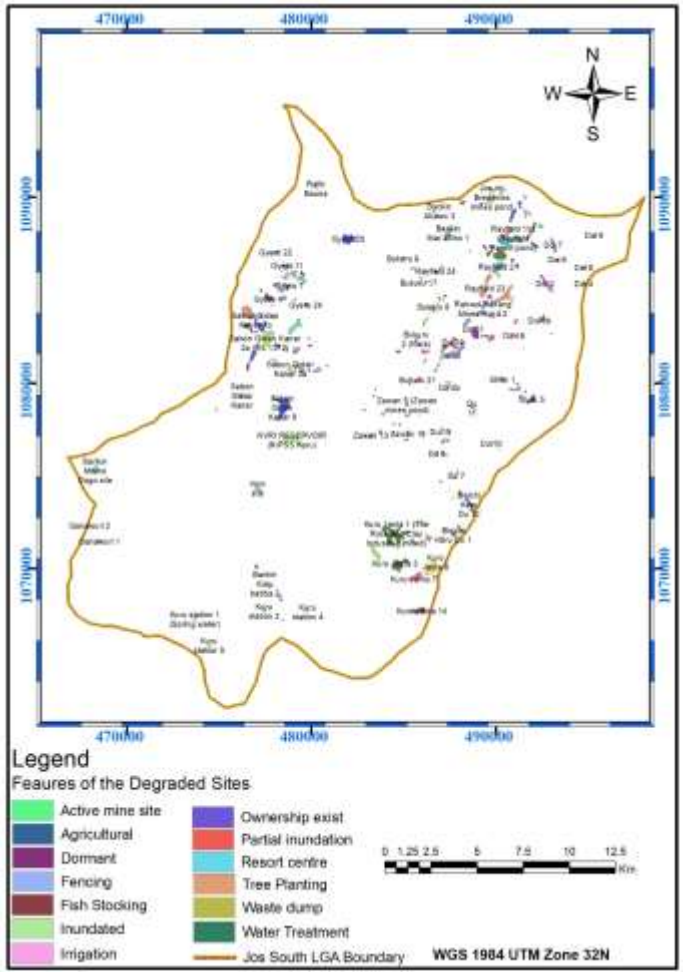



**Figure 4: Degraded sites with their features**

- The degraded sites were classified based on their functions (Figure 4).
- In Figure 5, the hot and cold spot regions at different confidence levels were 90%, 95% and 99%.
- There are hot spot clustered sites around Rayfield, Bukuru, Du, Sabon Gidan Kanar and Gyero areas.
- In contrast, Kuru Janta, Ganawuri, Vom and Barikin Kuru Babba were the cold spot areas experiencing very few degraded areas; the areas were mostly rocky hence there are less mining activities.

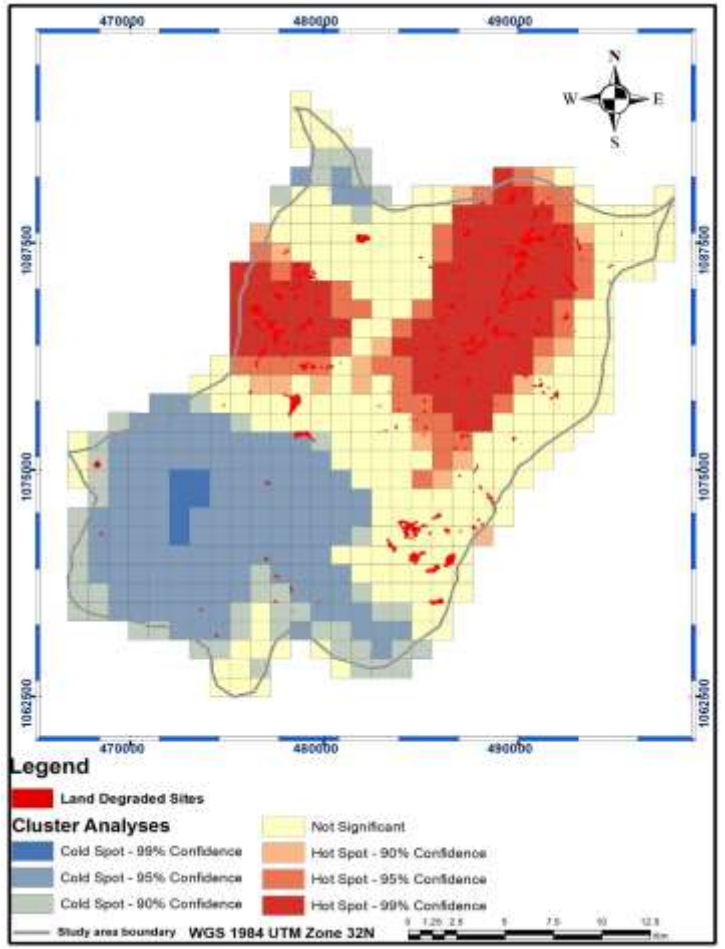



**Figure 5: Hot and Cold degraded sites**

# RESULTS



## Analyses of Land Use Classification in the Neighbourhood of Degraded Area

- The overall map accuracy and the Kappa coefficient accuracy were 77.82% and 73.16% respectively.
- The degradation that affected different land cover types was determined by overlaying the land cover data with the vector files of the abandoned mining sites.
- Special attention was paid to land cover classes that coincided with degraded areas such as inundation and bare degraded land
- Mine ponds and bare degraded lands account for a total of 9.45%, these were the most obvious land degraded covers with less economic activities going on (Table 5).

**Table 5: LULC distribution of the fused imagery**

| LULC CLASS | AREA ($Km^2$) | AREA (%) |
|---|---|---|
| Mine pond | 10.0052 | 1.95 |
| Settlement | 35.7792 | 6.99 |
| Exposed Rock Outcrop | 212.809 | 41.56 |
| Farmland | 92.9401 | 18.15 |
| Bare degraded land | 38.4006 | 7.50 |
| Vegetation | 122.163 | 23.85 |
| **TOTAL** | **512.0971** | **100** |

**Source:** (Geomatic Department, ABU Zaria, 18/6/2018)

# RESULTS



## Analyses of Land Use Classification in the Neighbourhood of Degraded Area

- In Figure 6, the settlement areas were concentrated in the central upper part of the area and are shown in red colour.
- In Figure 7, settlements are not properly planned; some houses are built indiscriminately near the abandoned mine pits without due consideration to dangers such may posit.

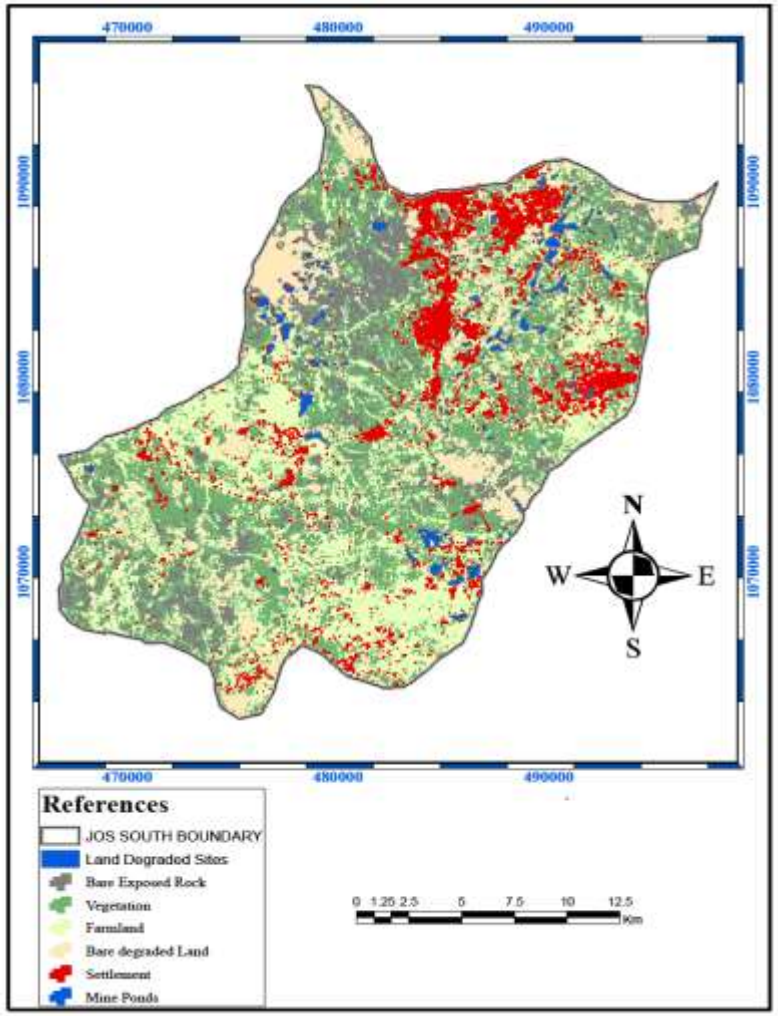



Figure 6: Land cover map;

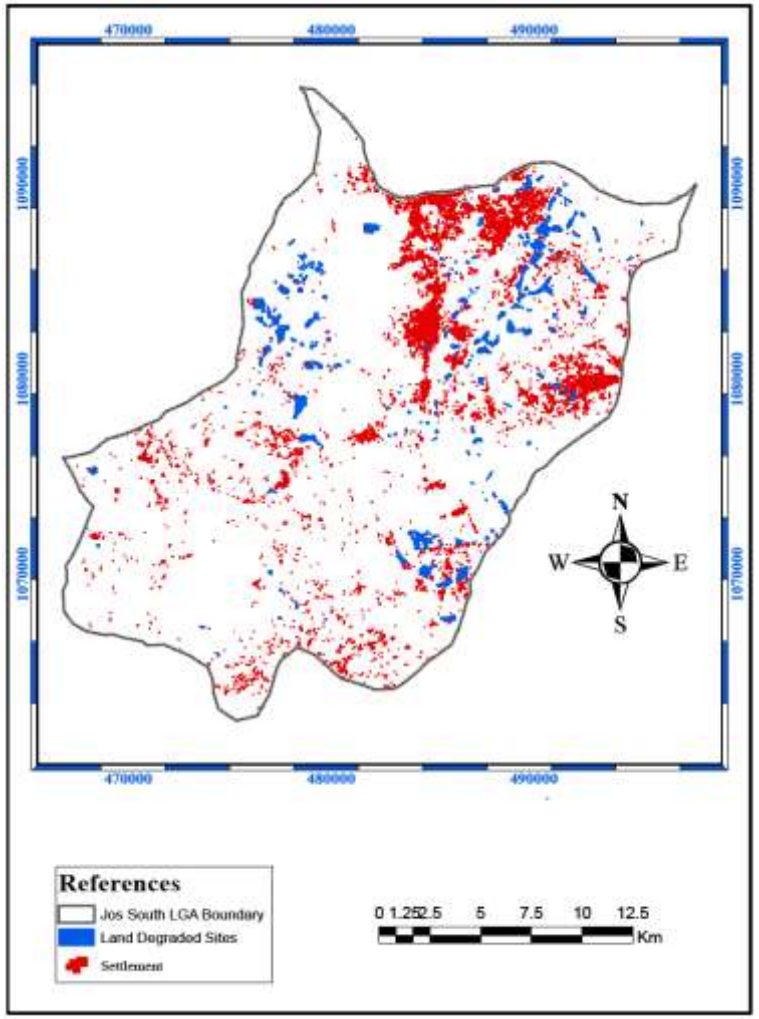
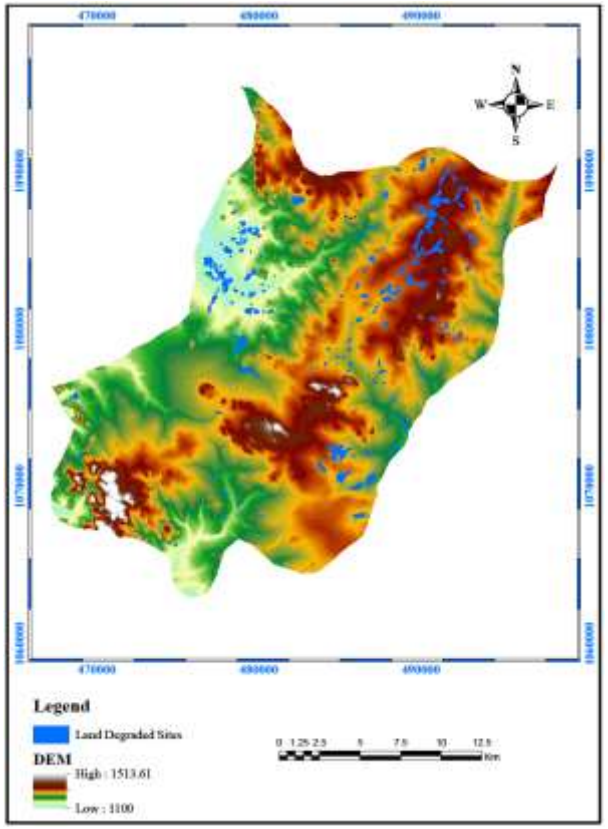



Figure 7: Relationship b/w Settlements and Land degraded sites

# RESULTS

## alyses of the Terrain in the Neighbourhood of the Degraded Sites



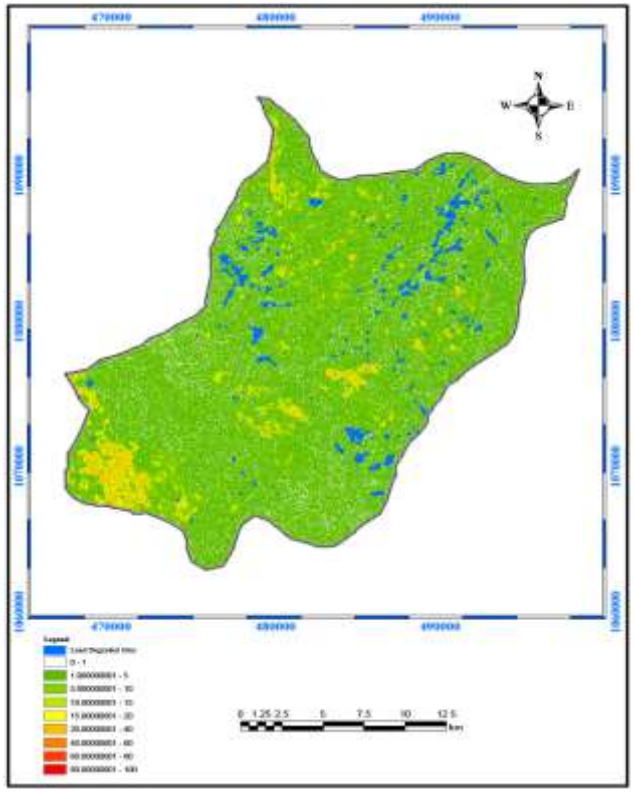



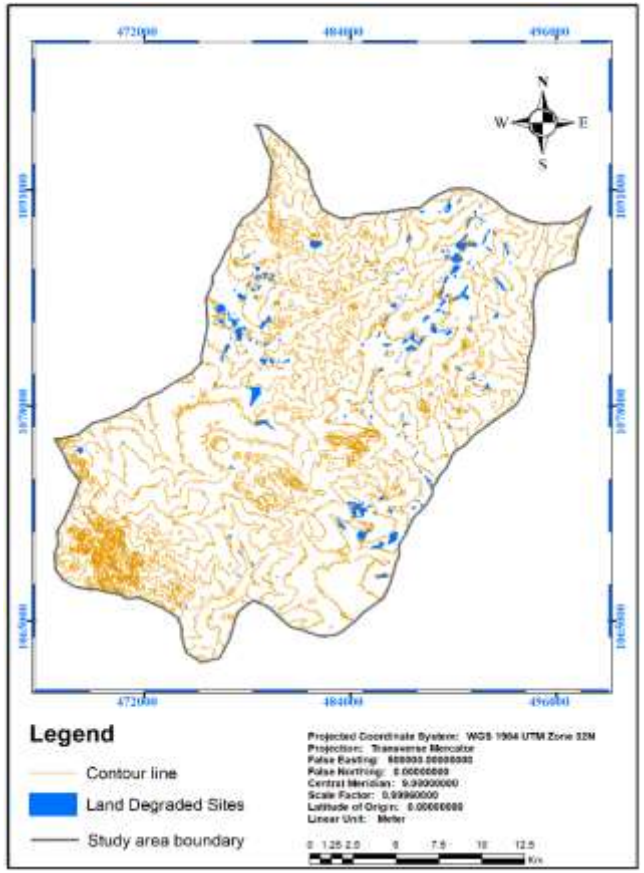
**Figure 8: Overlay Maps (Degraded Sites & DEM); Figure 9: Slopes derived from DEM**

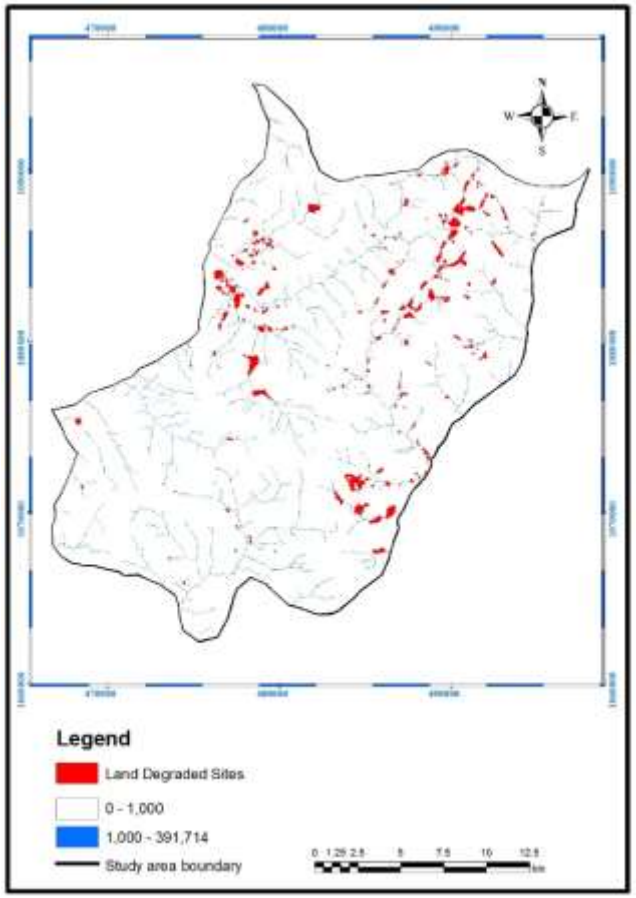
- Figure 8 is the overlay of the digitized degraded sites on the elevation model. This revealed the abandoned mining ponds spread randomly in the study area.
- The slope map in Figure 9 implied that land covers with depths (e.g. derelict ponds) have slope values of 0 to 0.99

# RESULTS



## alyses of the Terrain in the Neighbourhood of the Degraded Sites




- From Figure 10, the spatial location of the sites is irrespective of the contour values as some sites are located on a steep slope while others are on a gentle slope.
- In Figure 11, it is observed that most of the stream networks were connected with the degraded sites which proves the fact that most of the degraded sites are seasonally inundated.

**Figure 10: Degraded sites overlaid on contours; Figure 11: Degraded sites overlaid on the flow accumulation**

# CONCLUSION



- The study has effectively analysed mining induced land degraded sites using onscreen digitization, maximum likelihood supervised classification and DEM

- Mining not only alters the land cover and vegetation but also lead to erosion and degradation of land and deposition of the mining wastes in the nearby lands.

- Appropriate LULC in the neighbourhood of the degraded areas that could be utilized productively and be increased.

- The illegal mining going on in some degraded sites aggravate the degradation rate; urgent priority should be given to the implementation and enforcement of the existing mining and other environmental protection laws at all levels.

- Future research works should focus on land degradation monitoring by integrating GIS and satellite remote sensing with soil properties such as soil pH, texture, water capacity contents etc

Thank you for listening

Bedankt voor het luisteren

Any ?