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Research Article

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Spatio-Temporal Assessment of Quarry Sites in Mpape, Abuja, Nigeria

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Abstract

The study mapped and analyzed spatiotemporal variability of quarry sites in Mpape District, Bwari Area Council of Abuja. The study used high-resolution IKONOS satellite image, ASTERDEM and Hi-Target Differential GNSS receivers. The result showed that nine quarry sites exist in Mpape with three abandoned and six are active while three are located in the center of Mpape with one active and two abandoned. The depth analysis revealed that the deepest site is 25 m at Julius Berger quarry site and the lowest depth was 6 m at Dantata quarry site. The study also reveals that the rocky surfaces has the highest elevation and are located in the upper and lower region of Mpape. The quarry sites and settlement are located on a high elevation ground. Importantly, the study revealed that the derelict ponds were formed because of rigorous quarry activities, since there are no tributaries connecting each of the derelict ponds. The buffer analysis carried out at 100 and 150 m distances revealed that settlements are already engulfing the three quarry sites located at the core center of Mpape. Also, Chinese quarry site has been encroached, while the other six do not have settlement contiguous to them at 100 and 150 m buffer distances.

Keywords: Derelict ponds depth; Geospatial analysis; Land degradation; Settlement encroachment

Introduction

Quarrying is the process of obtaining quarry resources, usually rocks, found on or below the land surface. The difference between mining and quarrying is that quarrying extracts nonmetallic rocks and aggregates while mining excavates the site for metallic mineral de-posits. Some of the stones extracted are sandstone, limestone, perlite, marble, ironstone, slate, granite, rock salt and phosphate rock [1]. Quarry is a large artificial hole in the ground where stone, sand, etc. is dug for use as building material [2]. Quarries are places where materials are extracted from the surface of the earth [3].

Stone quarrying is the multistage process by which rock is extracted from the ground and crushed to produce aggregate, which is then screened into the sizes required for immediate use, or for further processing, such as coating with bitumen to make bituminous macadam or asphalt. The process begins with a detailed three-dimensional survey of the quarry face. This allows the explosives engineer to design the blast and to plot where the shot holes should be carried out safely and efficiently. The survey will show if there are any bulges or hollows in the face. A bulge will need more explosive while hollow areas require less explosive than normal [4].

However, extraction of raw materials from their natural habitats by quarry, mining, drilling, harvesting does significantly affect the natural environment [5]. Creating the quarries or pits requires the removal of virtually all-natural vegetation, topsoil and subsoil to reach the aggregate underneath. This leads to a loss of existing animal wildlife and huge loss of biodiversity as plants and aquatic habitats are destroyed. Additionally, adjacent eco-systems are affected by noise, dust, pollution and contaminated water [6-8]. Quarrying interferes with human settlement and wildlife habitat areas, leading to their displacement. Quarrying also leads to death, such as where workers are buried by the rocks [4].

Interestingly, quarrying provides income to local councils through taxation and many remote rural areas benefit from improved access. Quarry product are used as building stones, sand, pebble, slabs, etc., are also products of immense value conclusively, the whole activity including marketing and distribution provides various job opportunities and economic aids. Besides, quarry products are one of the most important non-metallic minerals and are indispensable commodities of roads, houses, and other engineering constructions as well as other domestic appliances [9].

Spatio-temporal analysis of land use and land cover changes have been widely carried out using multi-temporal remote sensing (RS), due to its high spatial and temporal coverage [10]. Spatio-temporal assessment of the quarry site using remote sensing technique over a period will give a clue over the rate at which the solid rock is crop out [11]. The integration of geographic information system (GIS) and remote sensing methods with the output in GIS platform has its advantage is the ability to incorporate different source data into change detection applications [12].

Akor and Achakpa [13] quoted that "environmental justice presupposes that citizens have the right of nature and the right to live in dignity within the environment". The environment and its natural base of Abuja and some urban communities in Nigeria, is seen as a commodity and therefore commercialized, leading to its destruction. The case of development is inadvertently creating destruction of landscape and natural architecture of Abuja and environs. The resulting effect being that the environment is not able to support residents' livelihoods and daily experiences. As quarrying is a continuous operation to meet the demand of construction, thus, it entails a constant scour of materials in all the nooks and crannies of the sites. These sites expand in depth and space (size) as exploration continues, leading to environmental changes in ecosystem and landform. Which has environmental, economic and health implications on the surrounding habitats and inhabitants. Consequently, there is need to characterize them for subsequent planning for restoration.

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Therefore, this study seeks to address the following questions: what are the geometrical characteristics of the quarry sites? How close are the sites to residential areas? Thus, this study aimed at carryout a spatio-temporal analysis of quarrying sites within Mpape District in Bwari Area Council of Abuja, Nigeria. The objectives of this study is to establish the spatial distribution of quarry sites and determine the geometrical characteristics of the quarry sites, and establish the proximity of the various active quarry sites to residential areas. This paper is divided into five parts, introduction, study area, materials and method, results and conclusion.

Study Area

Mpape is approximately 10 minutes' drive from the center of Abuja [14]. It is one of the districts in Bwari Area Council of the Federal Capital Territory (FCT), Abuja. It lies on the foothills and on the top of the famous Mpape Rocks that are easily sighted from the neighbouring Maitama District [15]. Geographically, Mpape lies between Latitudes 9.175699° and 9.113010° north of the equator and Longitudes 7.463892° and 7.524349° east of the Greenwich Meridian (Figure 1). It occupies a land area of 44.325 Ha and the largest slum settlement in Abuja and densely populated. With the rural-urban migration reportedly on the rise in Nigeria, the village has grown into an informal settlement with a population tethering over 1.1 million inhabitants without the commensurate infrastructure [14].

Mpape is almost predominantly underlain by high grade metamorphism and igneous rocks of Precambrian age generally trending, these rocks consist of gneiss, migmatites, granites and schist belt outcrops along the eastern margin of the area [16,17]. The rocky nature of Mpape makes it suitable for quarry business which thrives here [14,18].

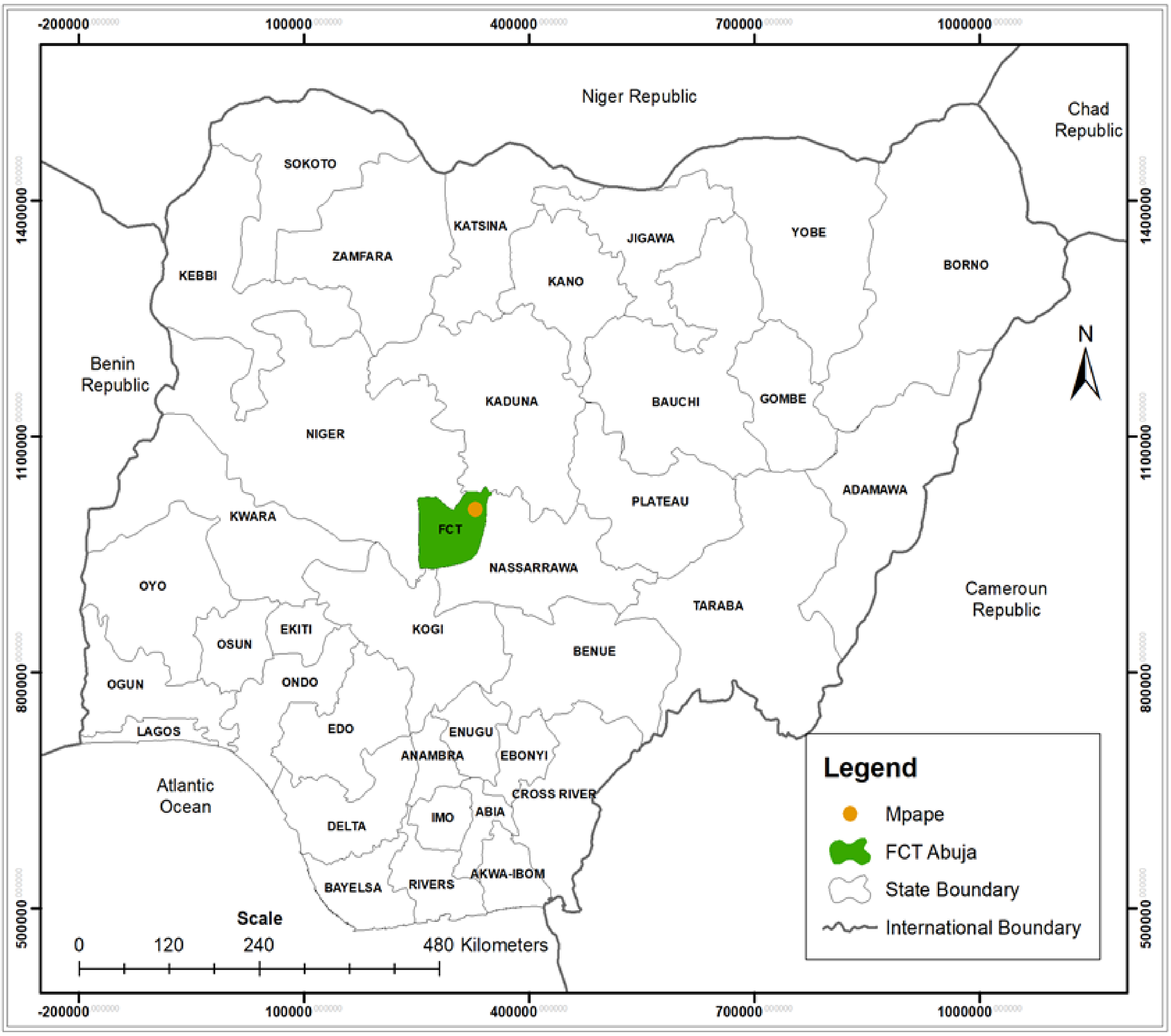

Figure 1: Nigeria showing Mpape in FCT, Abuja [22].

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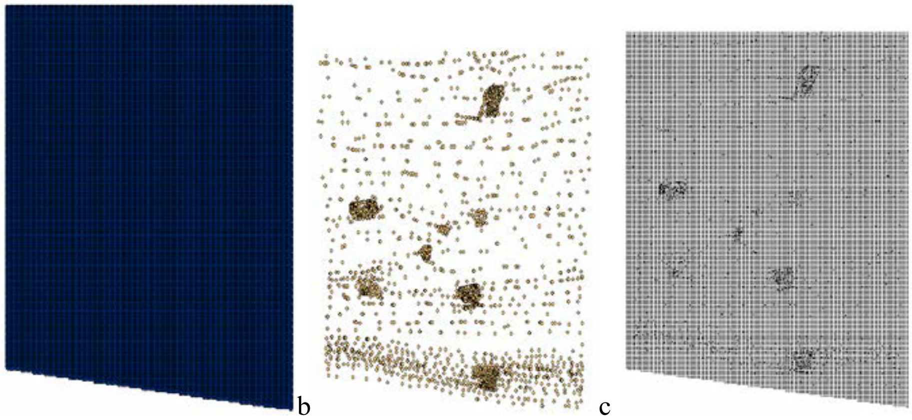

S/n	Statistics	a	b	C
1	Count	46666	2158	48824
2	Minimum	532	538	532
3	Maximum	814	793	812
4	Mean	661.16	668.4	29.54
5	Standard deviation	39.39	33.53	137.56

d

Figure 2: (a) A screenshot of the 30 m resolution extracted ASTERDEM elevation points in ArcGIS 10.1 environment. (b) A screenshot of generated TCX heights from Google. (c) A screenshot of merged extracted ASTERDEM and TCX elevation points. (d) Statistics of elevation points a, b, c. Source: Fieldwork (2017).

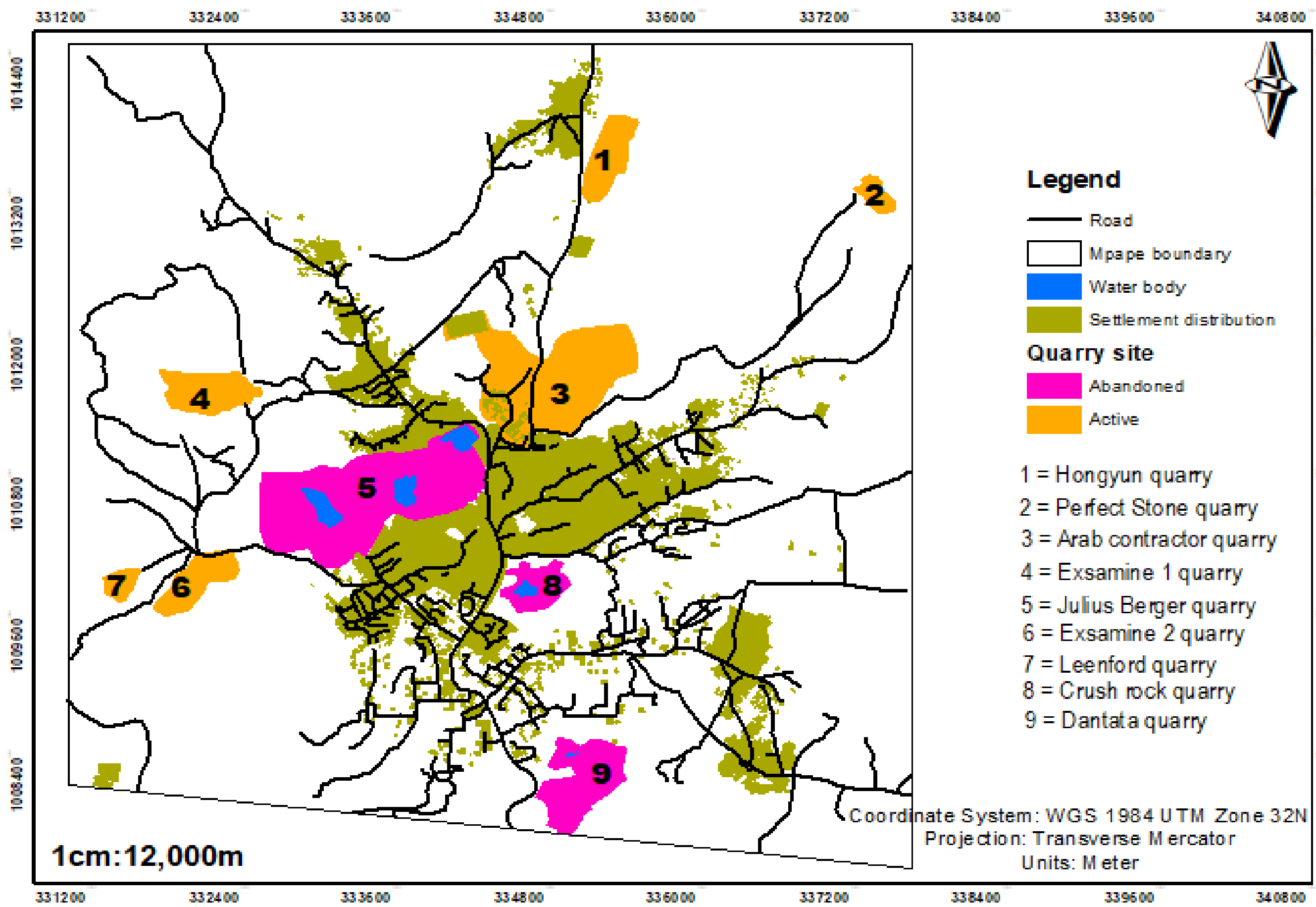

Figure 3: Distribution of quarry sites, settlements, roads and open-space. Source: Fieldwork (2017).

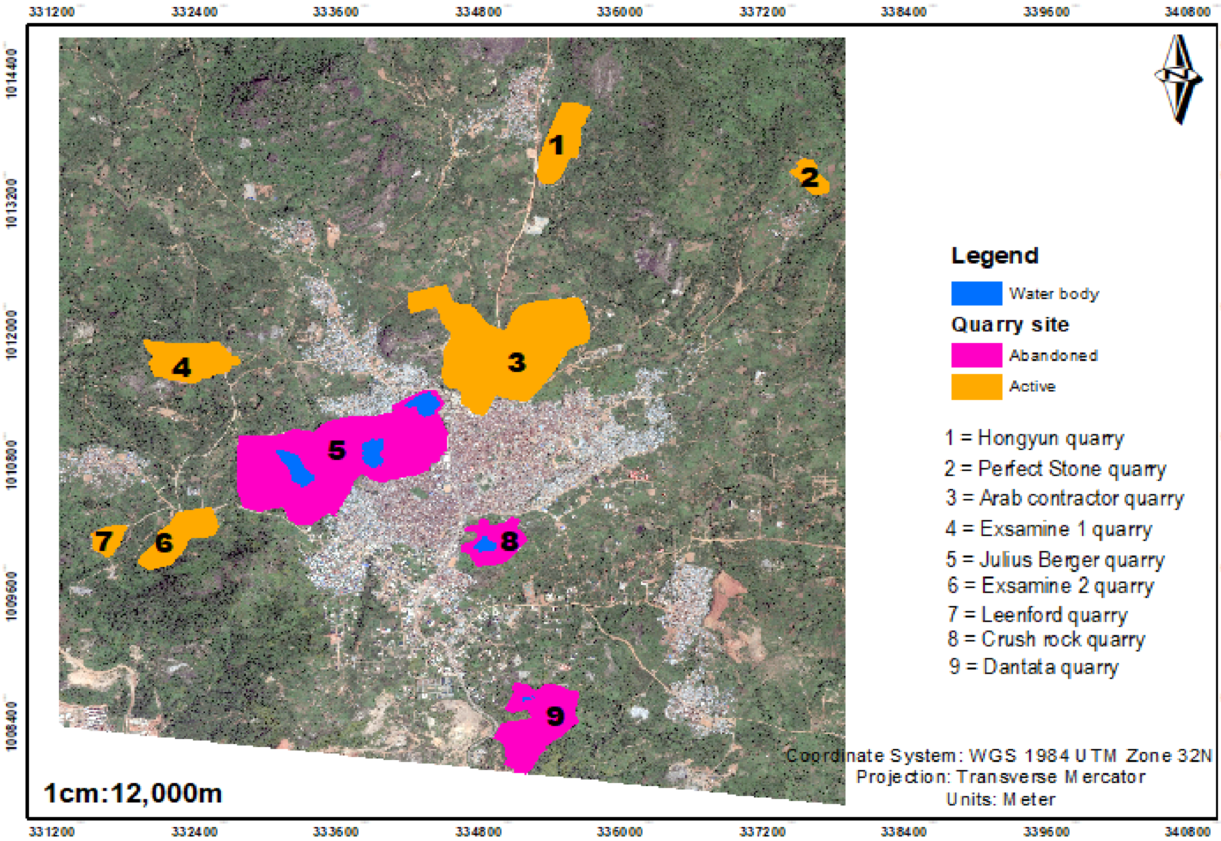

Figure 4: Quarry distribution overlaid on IKONOS image of 2015. Source: Fieldwork (2017).

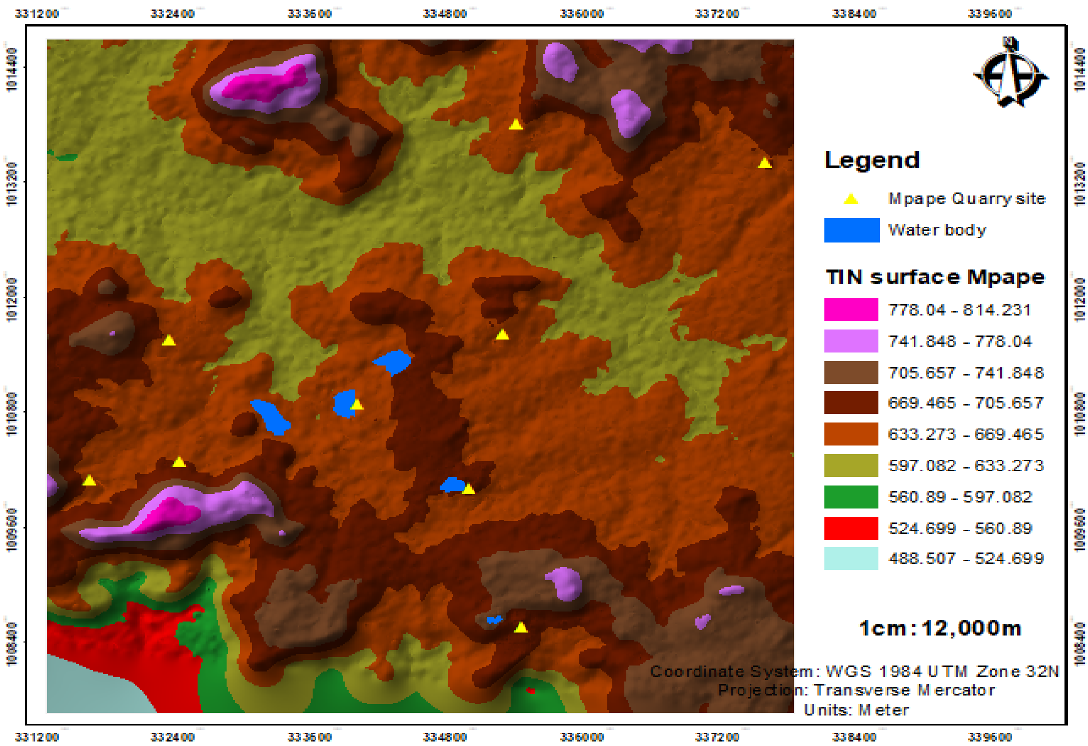

Figure 5: Terrain representation of Mpape by TIN surface with an overlay of quarry site and water body. Source: Fieldwork (2017).

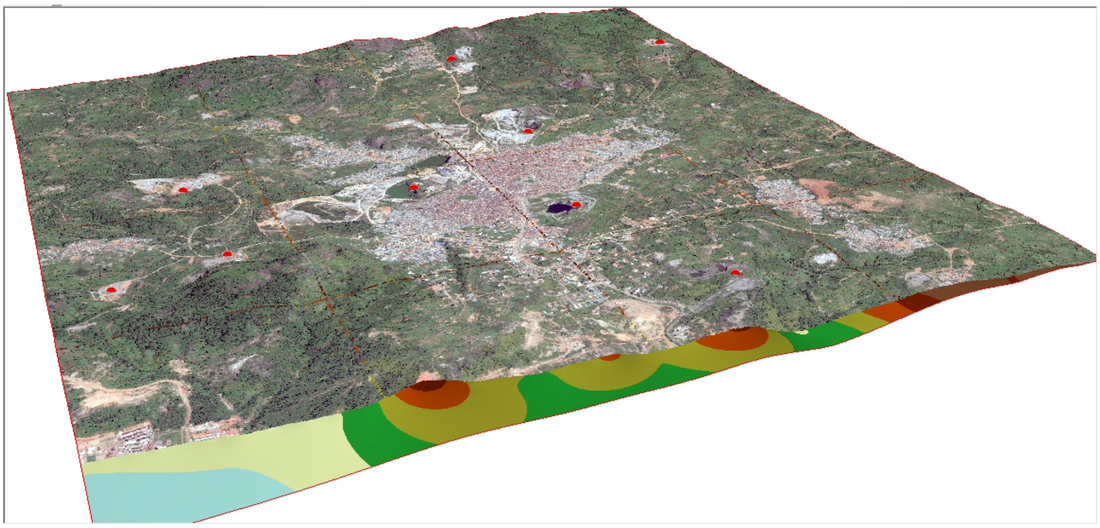

Figure 6: 3D-Model of Mpape with an overlay of IKONOS image of 2015 on TIN surface in ArcScene (Not to Scale). Source: Fieldwork (2017).

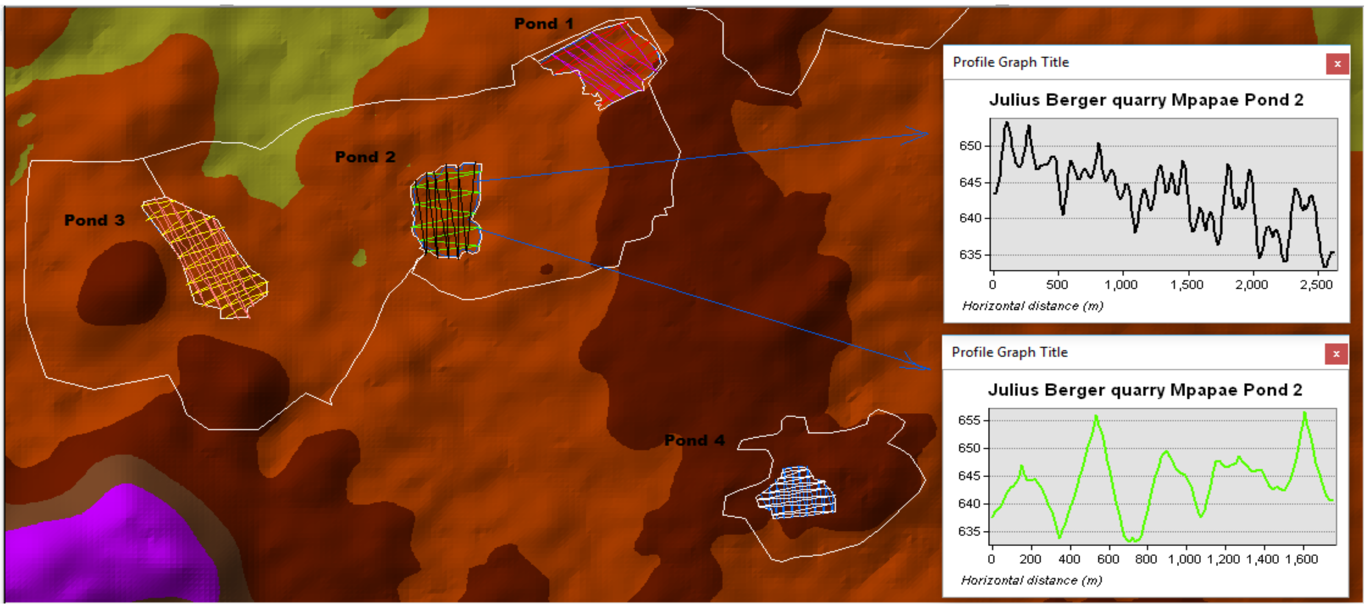

Figure 7: Transect analysis of depth profile of ponds within Julius Berger quarry site. Source: Fieldwork (2017).

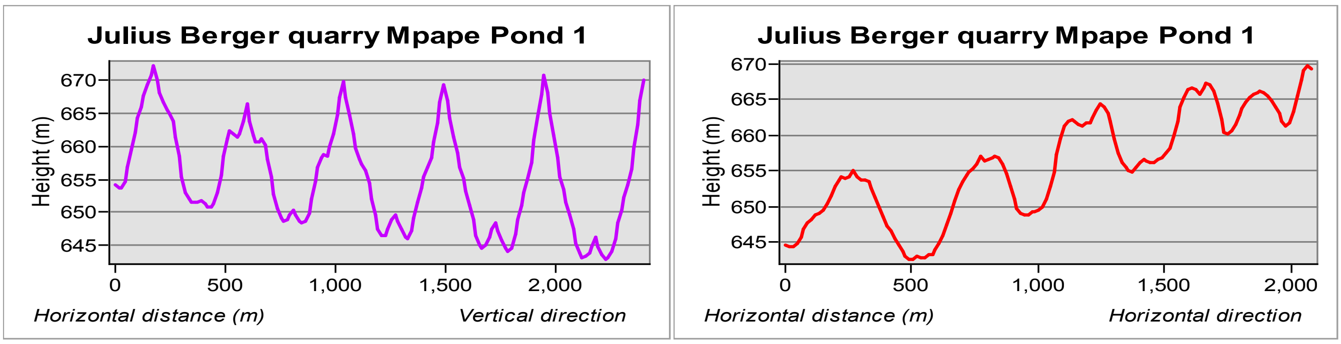

Figure 8: The depth profile of pond 1 within Julius Berger quarry site. Source: Author (2017).

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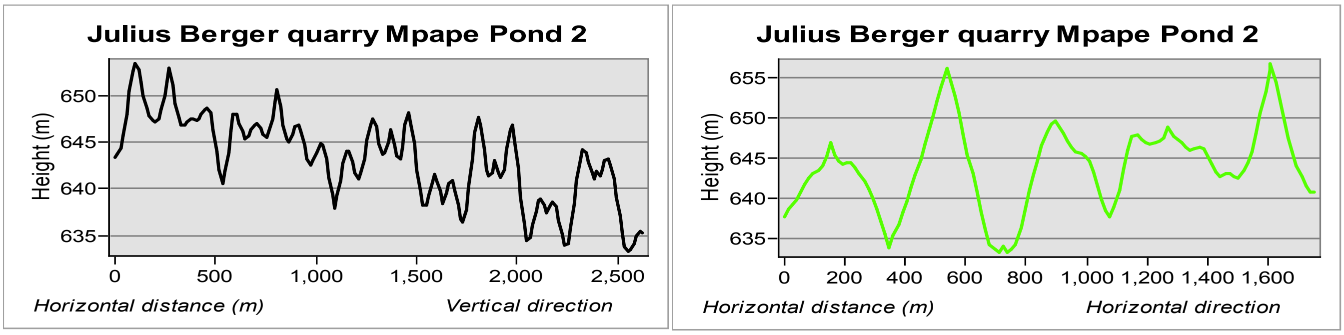

Figure 9: The depth profile of pond 2 within Julius Berger quarry site. Source: Author (2017).

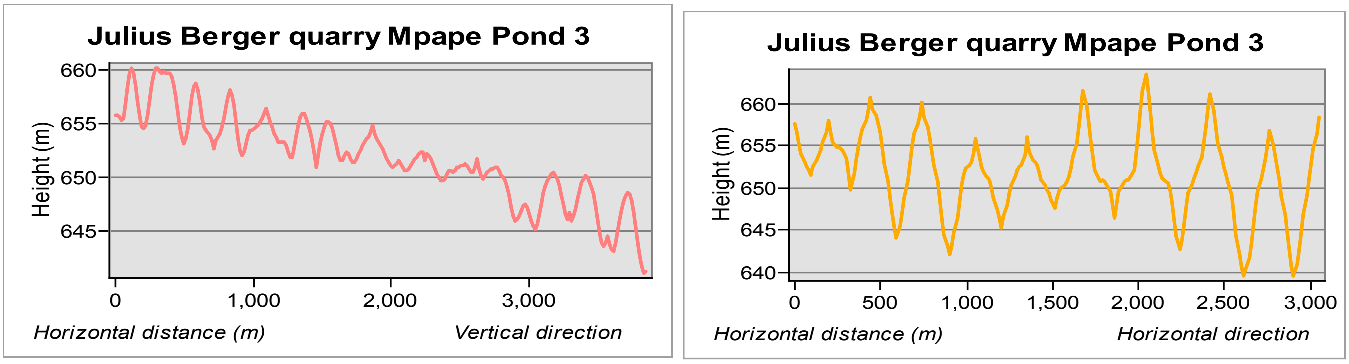

Figure 10: The depth profile of pond 3 within Julius Berger quarry site. Source: Fieldwork (2017).

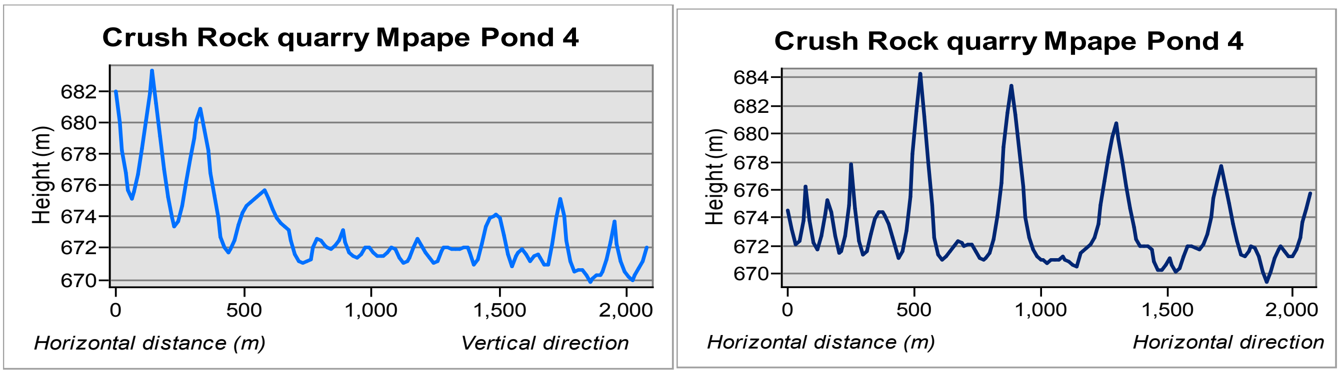

Figure 11: The depth profile of pond 4 within Crush Rock quarry site. Source: Fieldwork (2017).

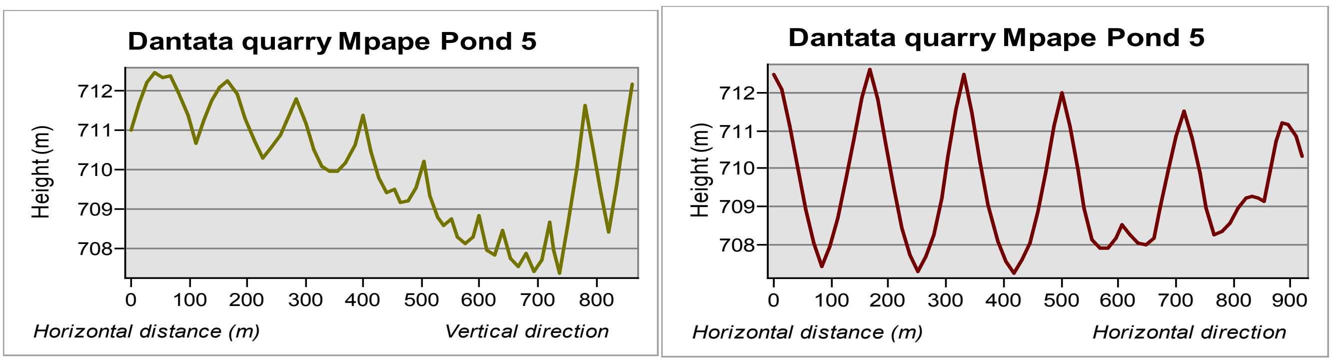

Figure 12: The depth profile of pond 5 within Dantata quarry site. Source: Fieldwork (2017).

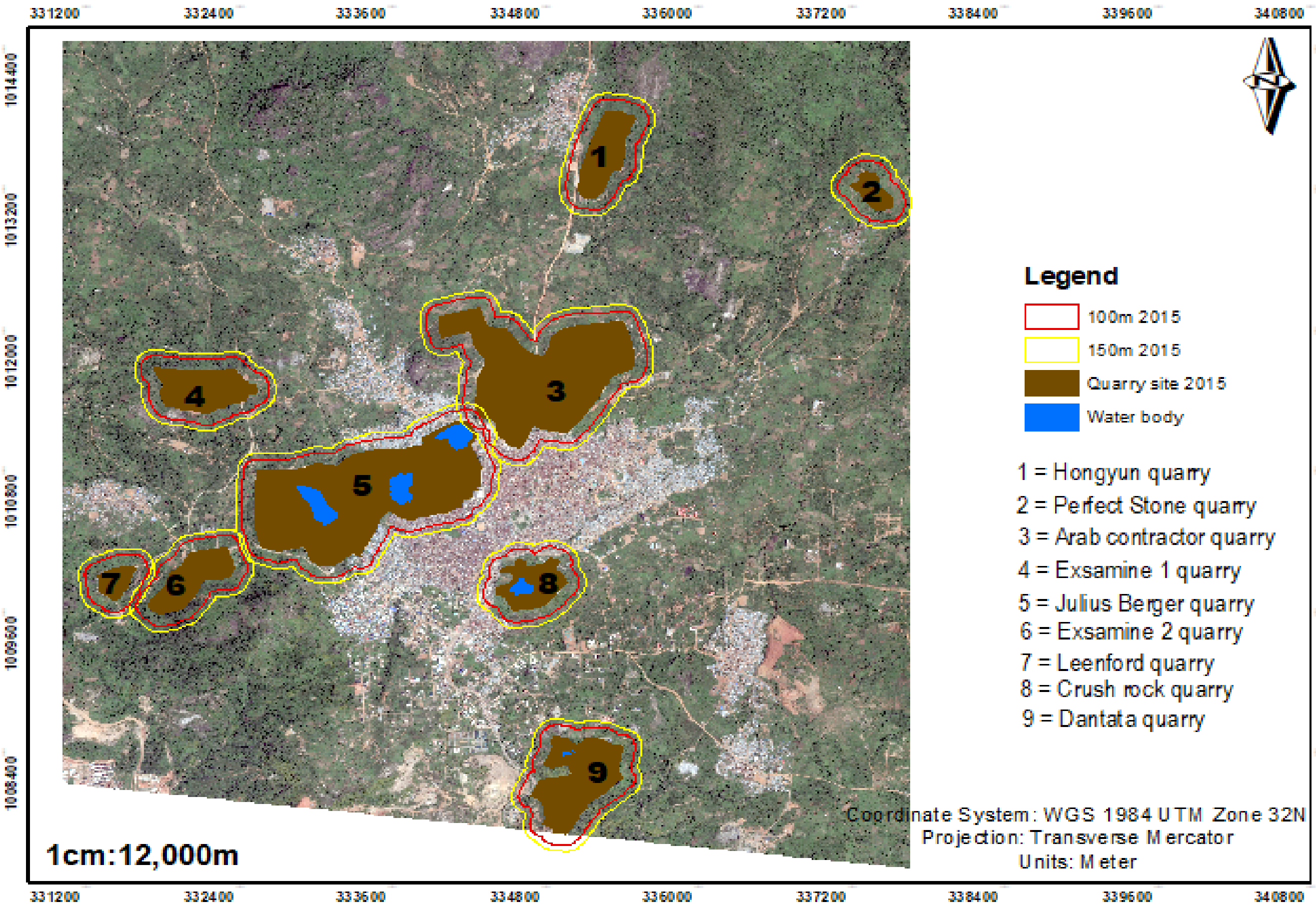

Figure 13: 100 m and 150 m Buffer of quarry site overlaid on IKONOS image of 2015.

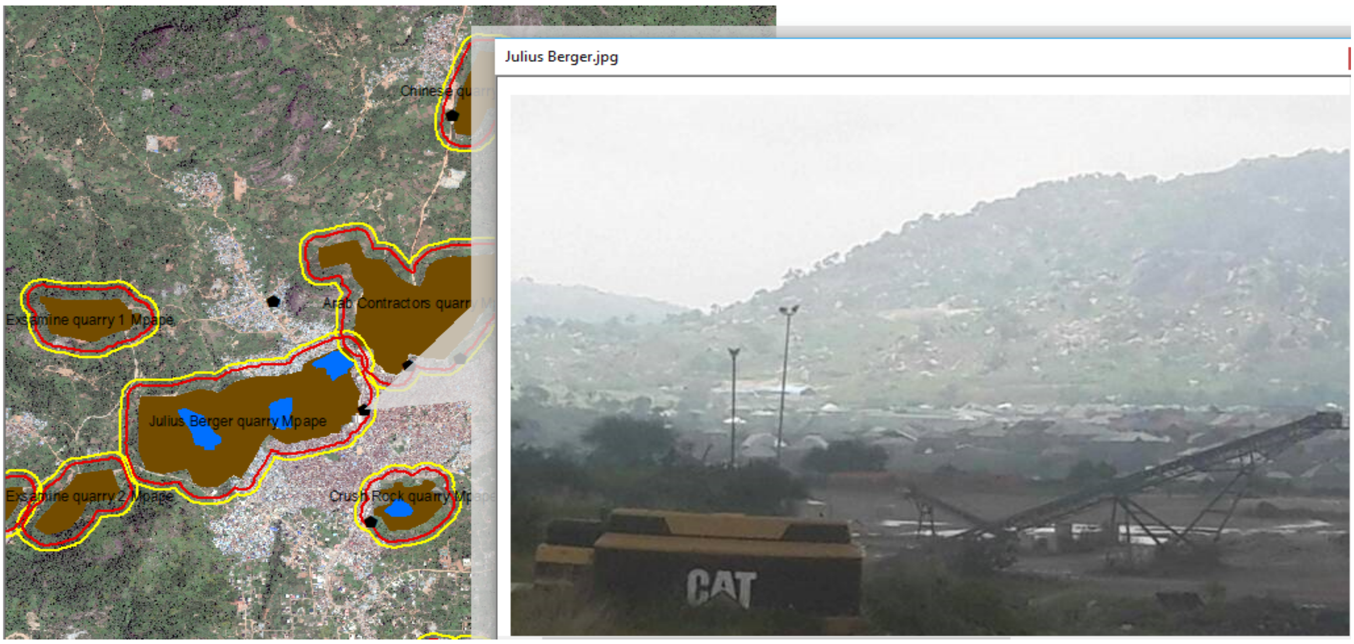

Figure 14: Geotagged photo of Julius Berger quarry at 100 m buffer distance. Source: Fieldwork (2017).

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Materials and Methods

Geographical information system (GIS) and remote sensing software were used to process, analyze and integrate the spatial data to achieve the aim of this research. Hi-Target Differential GNSS receiver was used for data capturing and the following softwares were used ArcGIS v10.1 Desktop, ENVI v5.1, TCX converter v20.30, Google Earth v7.1.2 2041, SAS planet. Unicode (an image downloading software). The Hi-Target V30 GNSS RTK model used and with accuracy: horizontal line: 1 cm+1 ppm and vertical line: 2.5 mm+1 ppm.

In this study, IKONOS remotely sensed image of Mpape for 2005 and 2015 was obtained from a vendor. Also, two cloud-free Landsat sensors; Enhanced Thematic (ETM+) sensor on-board Landsat 7 of 2002 and Operational Land Imager and Thermal Infrared Sensor (OLI and TIRS) on-board Landsat 8 of 2015 were used. The satellite scenes have the same climatic conditions with closely matching acquisition dates. This is to ensure that diurnal sun angle effect is minimized in the results. In addition, an Advanced Spaceborne Thermal Emission and Reflection Radiometer Digital Elevation Model (ASTERDEM), which was developed jointly by the U.S. National Aeronautics and Space Administration (NASA) and Japan's Ministry of Economy, Trade, and Industry (METI), was downloaded at the Land Product Distribution Analysis Archive Center (LP DAAC) website. The characteristics of the IKONOS used is as show in Table 1.

The quarry depths were collected through field data acquisition using Hi-Target Differential GNSS receivers. The IKONOS and ASTERDEM image data were clipped to the extent of Mpape. This operation enables larger files of image data to be reduced to free up computer disk space. The clipping was achieved using a shapefile of Mpape extent in ArcGIS 10.1 environment.

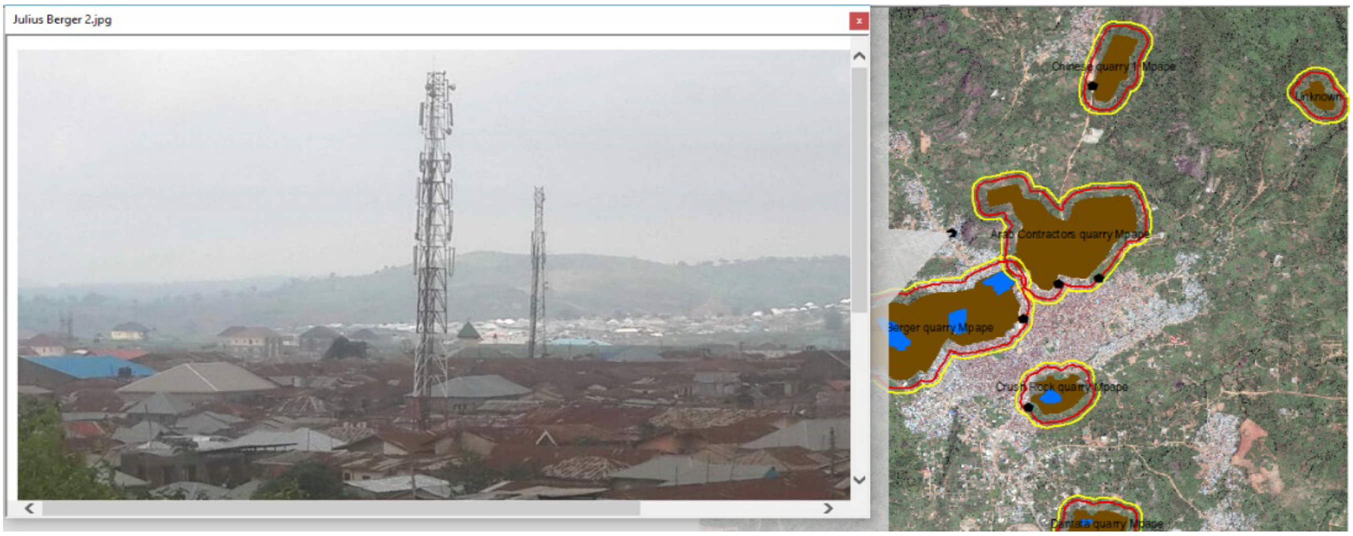

Figure 15: Geotagged photo of Julius Berger quarry at 150 m buffer distance. Source: Fieldwork (2017).

Figure 16: Geotagged photo of Arab contractor quarry at 100 m. Source: Fieldwork (2017).

For the mapping of the distribution of the quarry sites within Mpape, a vector model was adopted. Shapefiles were created for settlement, quarry site, roads, water body and open space (non built-up area) were created. A polyline feature type was used for creating a road layer while polygon feature type was used for others. An on-screen digitizing method was adopted. The quarry sites were digitized as active and abandoned polygons. This works simply by tracing each feature of interest in the IKONOS images and was achieved in the ArcGIS 10.1 environment.

Extraction of elevation points from ASTERDEM

Elevation points from the clipped ASTERDEM was extracted to create a smooth triangulated irregular network (TIN) for the creation of 3D model of Mpape and 46666 points were extracted and were converted to excel format. In ArcGIS 10.1 environment, raster to point tool in the conversion toolset was used to extract the points. The minimum elevation is 532 m and the maximum elevation is 814 m respectively.

Earth using TCX software and the spot heights were randomly

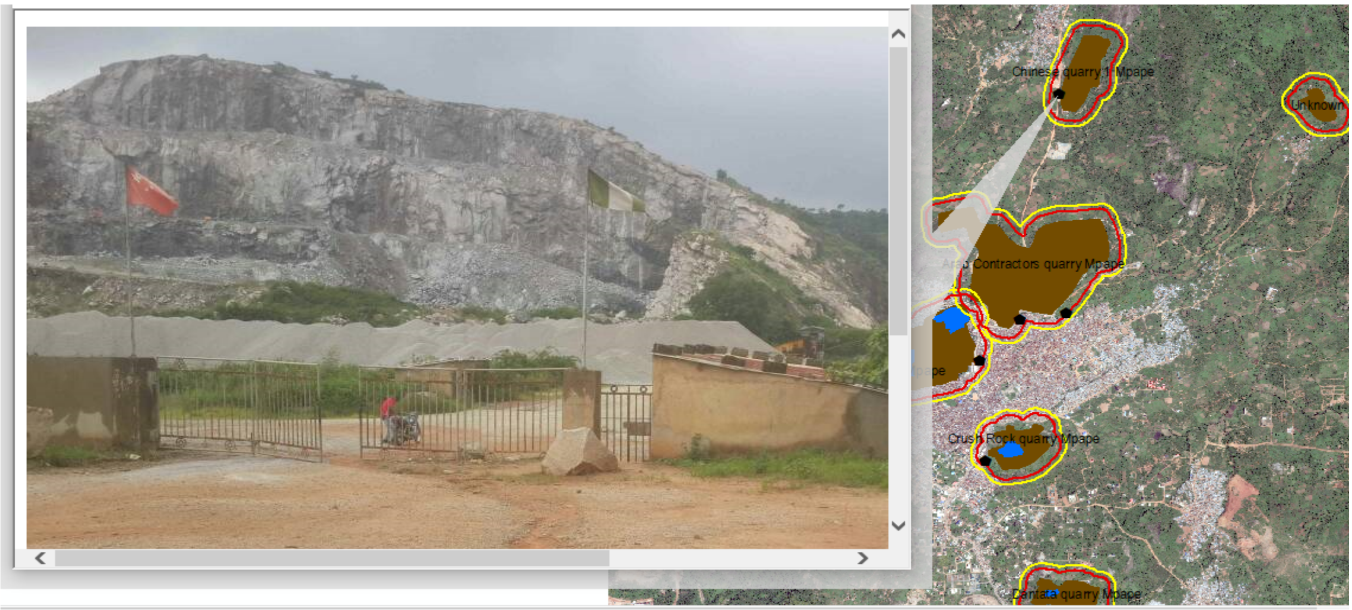

Figure 17: Geotagged photo of Hongyum quarry at 100 m buffer distance. Source: Fieldwork (2017).

Figure 18: Geotagged photo of Arab contractor quarry at 100 m buffer distance. Source: Fieldwork (2017)

collected, but closely at each quarry site for proper representation of the surface condition of each quarry site. The generated TCX spot heights from Google image were combined with the extracted DEM points for densification of the area. Then, the combined points were again converted to a resampled raster of 15 meters resolution for creation of a smooth TIN surface. This is a 2-dimensional representation of 3-dimensional data, which will assist in the analysis of the depth in each quarry site within the study area. Topo to raster tool in 3D analyst toolset in ArcGIS v10.1 environment was used. The extracted points and TCX points are shown in Figure 2.

Derivation of quarry depth using transect analysis

In order to determine the depth of derelict pond in each quarry, the TIN surface generated from the combination of elevation points from both ASTERDEM and TCX was used to generate the depth of each derelict pond formed as a result of intensive quarry operations. Series of horizontal and vertical lines were drawn across each derelict pond and different colors were assigned to each. The tool used in drawing these lines is "interpolate line" available in 3D analyst toolbar. After drawing each line, "profile graph" tool in 3D analyst toolbar was used to plot the depth profile of each drawn horizontal and vertical lines. The horizontal and vertical lines were drawn to ensure that the depth values were correctly interpolated from the TIN surface. A profile graphs was plotted for each line. The horizontal axis of the graph indicates the horizontal distance (in meter) drawn on the surface, while the vertical axis indicates the depth values from the TN surface.

Proximity analysis technique

Proximity analysis was carried out to determine the nearness of both the active and abandoned quarry sites to residential areas. The digitized quarry sites and IKONOS image of 2015 was used for this analysis. The buffer tool in analysis toolbox in ArcGIS was used for the analysis. A buffer distance of 100 m and 150 m was carried out for the quarry sites and was overlaid on IKONOS image of 2015. In addition, photographs of settlements nearer to both active and abandoned quarry sites were acquired in the site at distances of 100 m and 150 m respectively. The photographs were geotagged to locations on the ground and were plotted on the IKONOS image of 2015. This was done to show evidence of encroachment of settlement to quarry sites and impact of active quarry sites to residential areas.

Results

The findings reveal that Julius Berger is the largest in both area length while second largest is Arab Conractors, followed by Dantata, Exsamine 1, Hongyum, Exsamine 2, Exsamine 2, Crush Rock, Perfect Stone and Leenford respectively. In addition, Julius Berger quarry contains three derelict ponds, Crush Rock and Dantata has one each and are abandoned as shown in Table 2.

The spatial distribution of the quarry sites (active and abandoned) together with settlements, roads, and water body are shown Figure 3.

The quarry sites comprising settlements, roads, water body and open-space are seen, the active quarry sites are in golden color, while the abandoned quarry sites are shown in pink. Also, settlements are in green color; all the roads are in black; and water body that are ponds within the quarry sites are in blue color, while abandoned quarries are in pink color as shown in Figure 4.

The active quarries are Chinese, Exsamine 1, Exsamine 2, Arab Contractors, Perfect Stone and Leenford. The abandoned quarry sites are Julius Berger, Crush Rock and Dantata quarries. The three largest quarries are situated at the core of Mpape, two are abandoned quarries (Julius Berger and Crush rock) and the third is active (Arab contractors). The third abandoned quarry (Dantata) is located in the lower part of Mpape. Also, Exsamine quarry 1 and 2, Chinese, Perfect Stone and Leenford quarries are located remotely from the core of the settlement. Julius Berger quarry has three (3) derelict ponds within it due to its abandoned state; Dantata quarry and Crush Rock contains one derelict pond each. As regards to the distribution of the quarry sites, only six quarry sites were in the 2005 and they are Julius Berger, Arab Contractors, Crush Rock, Dantata, and Exsamine 1 and 2 quarry sites. In 2015, there are nine quarry sites with the addition of three quarry sites, namely: Hongyum, Perfect Stone and Leedford quarry sites. More so, Julius Berger, Arab Contractors and Crush Rock quarry sites are situated in core of the study area, while Dantata quarry site is located in the extreme southern part of Mpape.

Quarry depth derivation

The result as depicted in Figure 5 shows that the areas of highest elevation are in pink color and are between 778.04 m to 814.231 m; while areas of lowest elevation (light blue colors), are between 488.507 m to 524.699 m. The elevation points of the quarry sites are found around the orange and brown color areas, which elevation values are between 633.273 m to 669.465 m and 633.273 m to 705.657 m respectively. This signifies that quarry operations are being carried out on grounds with high elevations. In addition, it can be seen that the derelict ponds (water body) are formed on elevated areas within the quarry sites. This is contrary to the formation of water body in areas of low elevation. This could be due to blasting of rocks, therefore, creating astronomical holes within the region. The surface map shows that areas of highest elevation are in both the upper and lower region of Mpape. The high elevation in the upper region also signifies the concentration of rocky surface. The settlements were developed on high elevation ground with values between 633.273 m to 669.465 m and 633.273 m to 705.657 m. This could make the settlement not to be prone to flooding since it is on a high ground.

The terrain representation of Mpape by a TIN surface and a 3D model are shown in Figures 5 and 6. In Figure 6, the IKONOS image of 2015 and quarry (points) locations were overlaid on the TIN surface in ArcScene with a vertical exaggeration of one (1). This 3D model corroborates the TIN surface in Figure 5, showing the areas of highest elevation and rocky surface to be in both the upper and lower region of Mpape.

In Figure 7, the two horizontal (in green color) and vertical (black color) lines drawn over pond 2 within Julius Berger quarry site, the depth profile showed that the lowest point is 635 m and the highest is

Satellite	IKONOS
Ground Resolution (m)	4 m × 4 m except 4=0.82 m × 0.82 m
Quantization level	11 bit (256 levels)
Repeat coverage	3 days
Altitude	681 Km
Swath with	11.3 Km
Spectral bands (µm)	5 bands
	1=0.45-0.52 (blue)
	2=0.52-0.60 (green)
	3=0.63-0.69 (red)
	4=0.76-0.9 (NIR)
	5=0.45-0.90 (Panchromatic)

Table 1: Characteristics of IKONOS sensor used.

S/n	Quarry Name	Area (m^2)	Status	Number of derelict pond	Length (m)	Breadth (m)	Spatial location	
							Easting	Northing
1	Julius Berger	1,057,807.31	Abandoned	3	1,830.39	624.89	333619.651	1010890.816
2	Arab Contractors	921,693.95	Active	--	1,366.64	840.10	335162.355	1011654.773
3	Crush Rock	130,955.31	Abandoned	1	559.68	427.39	334890.580	1010042.628
4	Dantata	333,992.05	Abandoned	1	873.73	570.87	335380.749	1008468.893
5	Hongyum	183,796.85	Active	--	785.95	288.46	335430.264	1013760.543
6	Exsamine 1	215,243.82	Active	--	828.49	361.97	332228.363	1011837.533
7	Exsamine 2	175,918.56	Active	--	787.51	427.94	332327.283	1010225.097
8	Perfect Stone	56,792.23	Active	--	370.20	154.89	337561.226	1013432.702
9	Leenford	55,812.16	Active	--	346.00	256.20	331615.395	1010094.692

Table 2: The geometrical characteristics of quarries within Mpape district. Source: Fieldwork (2017).

S/n	Easting	Northing	Height (m)	Depth (m)
1	333211.805	1010756.695	674	11
2	333865.897	1010915.465	644	16
3	334302.365	1011356.453	660	19

Table 3: Spatial location with their depths of derelict ponds within Julius Berger quarry. Source: Fieldwork (2017).

655 m. Therefore, the depth of pond 2 within Julius Berger quarry site was interpolated to be 25 m. Similarly, the depth profiles of other ponds are shown in Figures 8-12.

The result of the generated Triangular irregular Network (TIN) from the ASTERDEM confirmed that the rocky areas have high elevation values as shown in Figure 11 and it happens to be where quarrying activities are occurring.

Furthermore, the result of the depths of the derelict ponds within the quarry sites showed that the three ponds within the abandoned Julius Berger quarry site are the deepest with values of 25 m. 20 m and 15 m respectively. Also, the pond within Crush Rock is 14 m and the one in Dantata quarry is 6 m. Although, the study intended corroborate this objective by the use of ground survey method using a Hi-Target GNSS receiver, access was not granted to the quarry sites due to bureaucratic bottleneck. However, the depths of the ponds within Julius Berger quarry was surreptitiously measured using the Hi-Target GNSS receiver. The values obtained for the three ponds are 19 m, 16 m and 11 m respectively as shown in Table 3. These values are close to the depths determined by the transect analysis method and this served as a corroboration.

Proximity of quarry sites to residential areas

The result shows that the settlement in the core centre of Mpape are engulfing the already abandoned Julius Berger Quarry at 100 m and 150 m. In addition, the settlements are also engulfing the active Arab Contractors Quarry, which is contiguous to the Julius Berger Quarry. Crush Rock and Hongyum Quarries are also been encroached at 100 m and 150 m buffer. Other remote quarries such as Dantata, Exsamine 1, Exsamine 2, Perfect Stone and Leenford quarry sites do not have settlements contiguous to them at 100 m and 150 m buffer as shown in Figure 13.

In addition, the study reveals that Julius Berger quarry showed abandoned state of the quarry and evidences of residential encroachment to it at 150 m as shown in Figure 14. The photograph of the active Arab Contactor quarry showed the encroachment of settlement to it at 150 m as shown in Figure 14. While Figures 15-18 reveals the conditions at other sites.

The implication of the spread in settlement is that the Julius Berger, Arab Contractors and Crush Rocks quarry sites are being engulfed by settlements. This can also be corroborated by the result of the 100 m and 150 m buffer analyses in Figure 13, together with the result of the geotagged photo of Julius Berger and Arab Contractors as shown in Figures 13-18.

Discussion

The study reveals that Julius Berger quarry is the largest with an area of 113.967 Ha, followed by Arab Contractors with an area of 88.01 Ha, followed by Dantata, Exsamine 1, Hongyum, Exsamine 2, Exsamine 2, Crush Rock, Leenford and Perfect Stone with areas of 33.958 Ha, 21.896 Ha, 17.530 Ha, 17.452 Ha, 14.910 Ha, 5.043 Ha and 4.483 Ha, resulting to loss of vegetal cover, this implies that a great magnitude of land degradation as a result of the quarry activities in the area, which is in agreement with the studies of Eshiwani, Mwangi, Abbas and Fasona, Fadhil [19-22] who also observed that quarrying activities result to degradation of the environment and huge loss of vegetation.

As regards to the distribution of the quarry sites, Julius Berger, Arab Contractors and Crush Rock quarry sites are situated in the core of the study area, while Dantata quarry site is located in the extreme southern part of Mpape. Also, Hongyum and Perfect Stone quarries are located in the extreme northern part of Mpape, while Exsamine 1 and 2, and Leedford quarries are located in eastern part of the study area. This was established by the mapping of the distribution of the quarry sites as shown in Figure 4. In addition, of all the quarry sites, two abandoned quarry sites (Julius Berger and Crush Rock) are located in the core of the study area, while only one active quarry site (Arab Contractors) is located in the core of the study area, causing diverse negative environmental impacts both bio-physical and socio-economic to the inhabitants, this is in agreement with Mwangi [20] study in Ndarugo area, Kiambu county Kenya and Sreenivasa and Reddy [9] in Bidadi, Bangalore rural district, Karnataka.

Furthermore, the result of the depths of the derelict ponds within the quarry sites showed that the three ponds within the abandoned Julius Berger quarry site are the deepest with values of 25 m. 20 m and 15 m respectively. Also, the pond within Crush Rock is 14 m and the one in Dantata quarry is 6 m. Although, the study intended to ascertain this objective by the use of ground survey method using a Hi – Target GNSS receiver. Access was not granted to the quarry sites due to bureaucratic bottleneck. However, the depths of the ponds within Julius Berger quarry was surreptitiously measured using the Hi-Target GNSS receiver. The values obtained for the three ponds are 19 m, 16 m and 11 m respectively. These values are close to the depths determined by the transect analysis method and this served as a corroboration. Therefore, it is certain that quarrying can results to the creation of derelict ponds. Similar finding has also been observed by Mustafa et al.

Urban sprawl is predominant in the city center of the study area. The implication of the spread in settlement is that the Julius Berger, Arab Contractors and Crush Rocks quarry sites are being engulfed by these settlements. This was corroborated by the result of the 100 m and 150 m buffer analyses in Figure 13, together with the result of the geotagged photo of Julius Berger and Arab Contractors as shown in Figures 14-18. Similarly, Sreenivasa and Reddy [9] investigated socio-economic and environmental perception of inhabitants of a quarry area-a case study of Bidadi, Bangalore rural district, Karnataka, they observed that many positive impacts were realized from a long-term quarry unit. In this context, provision of job opportunities, business, transport and communication, laborer etc. which attracts inhabitants. However, negative impact also prevails in this environment like health hazards, crop loss (both in productivity and health) reduction in livestock and vegetation population etc.

Conclusion

In this study, the distribution of quarry sites within Mpape District of Abuja has been investigated through fieldwork and mapped using high-resolution IKONOS satellite image. Nine quarrying sites were identified within the study area. Three quarry sites are abandoned, namely: Julius Berger, Crush Rock and Dantata quarries. The remaining six are active, namely: Arab Contractors, Hongyum, Exsamne 1 and 2, Perfect Stone and Leenford quarry sites. Julius Berger quarry site is the largest and contains three derelict ponds; Crush Rock and Dantata quarry have contain one each. Also, Julius Berger, Arab contractor and Crush Rock quarry sites are located in the core center of Mpape, while others are dispersed across the study area.

The study revealed that there was an increase in the sizes and numbers of quarry sites from six in the year 2005 (area of 2.44 Km^2) to nine in the year 2015 (area of 3.13 Km^2). On the depths of the derelict ponds formed as a result of rigorous quarrying, the three ponds within the abandoned Julius Berger quarry have the highest depths of 25 m, 20 m and 15 m respectively. The pond in the abandoned Crush Rock has a depth of 14 m and the pond in abandoned Dantata quarry has the least depth of 6 m. Furthermore, the study has shown that the settlements in the core center of Mpape have already encroached Julius Berger, Crush Rock and the active Arab Contractors quarries at distances of 100 m and 150 m. thus, this study concludes that despites the significant role of quarrying activities, they are resulting to environmental degradation which are harmful to both man and his environment.

Recommendation

This study therefore recommends that development authorities and environmental protection agencies should formulate regulations and policies to protect the environment. To make quarrying companies to convert abandoned derelict ponds into socio-economic use and plant trees, while residential areas to keep off quarrying sites with a minimum distance of 150 m to 200 m. A further study should be conducted on environmental impact of quarrying to unravel the level of destruction being made to the ecosystem by quarrying activities.

References

1. Nartey VK, Nanor JN, Klake RK (2012) Effects of quarry activities on some selected communities in the lower Manya Krobo District of the Eastern Region of Ghana. Atmos Clim Sci 2: 362-372.
2. Cambridge Dictionary (2016) Quarry. The British Dictionary.
3. University of Leicester (2016) Introduction to quarries. Department of Geology, University of Leicester, UK.
4. North Stone (2016) Quarrying process and quarry products.
5. Fedra K, Winkelbauer L, Pantulu VR (2005) System environmental screening: Application in the lower mekong basin. international institute for applied systems analysis, Laxenburg, Austria, p: 169.
6. Guach HG (2001) Multivante analysis in community ecology. Cambridge University Press, London, UK, p: 85.
7. Okafor FC (2006) Rural development and the environmental degradation *vs.* protection. In: Environmental Issues and Management in Nigeria Development pp: 150-163.
8. Anand PB (2006) Waste management in Madras. Environ Urbanization 11: 161-176.
9. Sreenivasa R, Reddy RV (2014) Socio-economic and environmental perception of inhabitants of a quarry area: A case study of Bidadi, Bangalore Rural District. Int J Eng Sci Inv 3: 11-22.
10. Ashraf A, Imran M, Shahbaz A (2015) Protecting agricultural land in developing countries: A case study from Lahore, Pakistan. Int J Adv Remote Sens GIS 4: 1181.
11. Adeoye NO (2012) Spatio-temporal analysis of land use/cover change of Lokoja: A confluence town. J Geogr Geol 4: 40-51.
12. Ravindra GJ, Mundhe NN (2013) Hybrid image classification technique for spatio-temporal analysis of Pune City. Trans Inst Indian Geogr 35: 214-223.
13. Akor G, Achakpa P (2011) Mobilizing local communities against degradation in Abuja, Nigeria: On the frontline of environmental justice and defence of lives and livelihoods. Published as part of the Effectius Newsletter, p: 14.
14. Jimoh I (2017) The Abuja inquirer. Mpape: A tale of modernity and slum 2: 1.
15. Dawam PD (2000) The geography of Abuja federal capital territory. Famous/Asanlu Publishers, Minna, Nigeria.
16. Federal Capital Development Authority (FCDA) (1979) The master plan for Abuja the new federal capital of Nigeria. FCDA, Abuja, Nigeria.
17. Federal Capital Development Authority (FCDA) (1998) Abuja Handbook. FCDA, Abuja, Nigeria.
18. Okeke J (2016) The authority newspaper. Mpape: The Good, the Bad and the Ugly.
19. Eshiwani F (2014) Effects of quarrying activities on the environment in Nairobi County: A case study of Embakasi district. Master Thesis, University of Nairobi, Kenya.
20. Mwangi SN (2014) An assessment of environmental impacts of quarrying activities in Ndarugo Area, Kiambu County. Bachelor Degree Project, Kenyatta University, Kenya.
21. Fadhil AM (2009) Land degradation detection using geo-information technology for some sites in Iraq. Journal of Al-Nahrain University 12: 94-108.
22. AGIS (2017) Abuja Geographic Information Systems 2: 1.