

Analysis Of Volcanic Craters And Their Socio-Economic Importance On The Biu Plateau, Borno State, Nigeria

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Abstract: *This research examined the analysis of volcanic craters on the Biu plateau and their socioeconomic importance. The objectives of the study are to identify the craters; determine the socio-economic relevance of the craters and examine the impact of these activities on the craters. Data used for this study were generated from field observations, topographic map and group interview. Three sampled craters namely Kumba, Tilla and Jali Tagurmi were purposively selected for the study. Geomorphic processes, vegetation types and human activities were observed in relations to slope gradient. Three group interviews and participatory rural appraisal were conducted in the vicinity of each of the craters on the socio-economic importance. Results showed that there are fourteen craters on the Biu plateau; four large (> 300m) in diameter, five medium (200-300m) and five small (< 200m). The morphology of the Kumba crater is conical with an elevation range of 700m to 765m, Tilla crater is circular with elevation range of 736m to 742m while the Jali crater has an oval shape with spot height of 690m to 740m asl. Denudational processes observed on the rims of the craters include weathering, sheet, rill, gully erosions and mass wasting (rock fall, soil creep, debris creep and slides). Socio-economic activities associated with the craters according to group interview and participatory rural appraisal include livestock watering, market gardening, quarrying, tourism, medication and domestic water supply. Other related negative human activities observed include bush burning, deforestation, accelerated erosion, poaching, hunting, and extraction of fuelwood. From the findings of the research it is recommended that public enlightenment campaign on environmental management be conducted, sustainable environmental management of land based resources be ensured. Access roads, afforestation, beneficial cultural practices and tourism be encouraged.*

I. Introduction

A volcanic crater is a relatively circular depression on the earth's surface caused by volcanic activity. It is typically a basin, within which a vent is located from which lava erupts in form of gases, and ejecta are emitted. A crater can be of various sizes and sometimes of great depth. During climactic eruptions, the volcano's magma chamber may be evacuated for the area above it to subside to form a crater or a caldera. In typical volcanoes, the crater is situated at the top of the cone, formed by pyroclastic materials (or debris). In some, the craters may be situated on the flanks of volcanoes and these are commonly referred to as flank craters. Most volcanic craters may either be fully or partially filled with runoff or melted snow to form a crater lake.

According to Strahler and Strahler (2002), the relationship that exists between man and landforms can be viewed in at least three ways. First, as man made landforms, secondly, the negative and positive roles of landforms in relation to economic development and thirdly, in the entire field of applied geomorphology under landform classification and development. Man as a geomorphic agent has received inadequate attention from geomorphologists because geomorphology has a strong geologic component interest in natural processes as an agent of landform formations. This situation was understandable when human population and impact on the earth was insignificant. Currently, with the human population of over seven billion using advanced technology that are transforming the landscape at ever increasing rate, there is a need to focus on man as a geomorphic agent; for instance, it is estimated that in South African mine fields, some 160,000 kg of earth materials are removed and accumulated elsewhere daily, a figure which compares favourably with the sediment load of some main geomorphic agents such as wind and water. Landforms are also being formed and / or remoulded through agriculture, constructional activities and excavations (Kagu, 2008). Man-made landforms can be classified into the direct and indirect landform types. The direct manmade landform features include landform created during construction, agriculture and mining activities. Examples include canals, dams, mine dumps, road cutting, excavations, tunnels, embankment and underground shafts like wells, boreholes, mining, and underground reservoirs.

Statement of the problem

Biu is a volcanic plateau, characterized by various spectacular geomorphic features which make the area very unique when compared to its surrounding environment. Some studies consider the Biu plateau as the end of the North-North West (NNW) branch of the continental sector of the Cameroon Volcanic Line (CVL) (Turner, 1978; Fitton, 1980; Halliday, et al, 1988 and Lee, et al, 1996). It has been observed that the Biu and Jos Plateaux have similar major and trace elements and that the Jos Plateau lavas have similar range of isotopic compositions, overlapping the lava of the CVL as a whole (Rankenburg, et al., 2004). According to Turner, (1978), the Biu Plateau evolved in three stages during two periods of volcanism: an early fissure type eruption; formation of relatively large tephra ring volcanoes and building up of localized thick lava piles up to 250m in the southern part of the plateau. According to studies carried out by Barfod et al. (1999), based on diffusional constraints of “He” in mantle xenoliths of the CVL and pollen dating by Salzmann (2000) of maar sediments from the Tilla crater on the Biu plateau, the rough estimate of the age of the last magmatic period is put at < 50 million and > 25 million years.

A base line socio-economic survey, carried out by Amaza et al. (2007), revealed that about 68% of the people on the Biu Plateau are farmers engaged in various agricultural activities on the plateau that lead to the modification of the plateau (Amaza,2007). Bwala, (2011) focused on the domestic water availability and utilization on the Biu plateau that serves as the major source of both surface and underground water in the area. However, no similar study has focused on the analysis of volcanic craters and their socio-economic importance on the Biu plateau. Therefore, this study intends to fill this gap by focusing on the craters, their socio-economic importance and the impact of these activities on the craters.

Aim and Objectives of the Study

The study examine the analysis of Volcanic Craters and their socio-economic importance on the Biu Plateau. The specific objectives of the study are:

- i. to identify the Craters on the Biu Plateau;
- ii. determine the socio-economic relevance of the craters.
- iii. examine the impact of these activities on the craters

Research Questions

- i. How many Craters are there on the Biu plateau?
- ii. What are the socio-economic importance of the craters?
- iii. What are the impact of these activities on the craters?

Methodology

This section discuss the sources of data, methods of data collection and analysis.

Sources of Data

Both primary and secondary sources of data were used for this study. The primary data include Group interview and Participatory Rural Appraisal (PRA) were used to collect data on the socio-economic importance of the craters to the immediate communities. Secondary sources of data were obtained from the use of the Biu topographic sheet 133 (1:100,000).

Sampling Techniques

Using the topographic map of Biu sheet 133 on the scale of 1:100,000 and ground truth, the craters were categorised into three major groups based on the diameter of their rims as follows: Large (> 300 meters), Medium (200 – 300 meters) and Small (< 200 meters). Purposive sampling technique was used to select one crater from each of the three groups for detailed analysis. The respondents for the group interview and PRA were purposively selected in the field while carrying out one socio-economic activity or the other for group discussion as shown in Plate.1.



Plate.1: Group Discussion at Market Gardening around Tilla Crater Lake

Source: Fieldwork, 2014

Statistical Analysis of Data

The data generated on the socio-economic importance of craters were analysed using descriptive statistics.

II. Results And Discussion

Using the Biu topographic map, sheet 133 (1: 100,000) and ground truthing, four (4) large craters, five medium size craters and five small craters were identified which gives a total of 14 craters on the Biu plateau as shown on Table 1.

Table 1. Distribution of volcanic craters on the Biu Plateau

S/No	Large (> 300 m)	GPS Coordinates (Northing)	Easting
1.	Kumba Crater (Gar Kidi)	10° 48'20.486'' N	12° 7'81.533'' E
2.	Gurara Crater (Gar Gurara)	10° 36'36.616'' N	12° 9'43.291'' E
3.	Zamta Crater (Gar Zamta)	10° 40'56.895'' N	12° 1'13.285'' E
4.	Padam Crater (Gar Padam)	10° 50'47.798'' N	12° 7'22.654'' E
	Medium (200-300 m)		
5.	Kidi Crater (Gar Kidi)	10° 46'20.485''N	12° 7'8.153'' E
6.	Hujiga Crater (Gar Hujiga)	10° 49'26.901''N	12° 4'16.184''E
7.	Kufakana Crater (Gar Kufakana)	10° 44' 31.449''N	12° 9'11.084''E
8.	Hizhi Crater (Gar Hizhi)	10° 40'28.757'' N	12°4'42.026''E
9.	Tilla Crater (Gar Tilla)	10° 39' 50.066''N	12° 8'47.014''E
	Small (> 200 m)		
10.	Jali Tagurmi Crater (Gar Jali Tagurmi)	10°42'38.896''N	12° 7'40. 186 E
11.	Tilla Crater (Nkwar Tilla) (Gar Nkwar Tilla)	10°38'37.079''N	12° 9'57.136''E
12.	Sugur Crater (Gar Sugur)	10°44'34.966''N	12° 5'58.185''E
13.	Pidarta Crater (Gar Pidarta)	10°55'22.147''N	12° 0'27.156''E
14.	Sugwi Crater (Gar Sugwi)	10°53'15.524'' N	12° 1'29.767''E

Source: Fieldwork, 2013

The result also revealed that the pattern of the distribution of the craters on the Biu plateau is not evenly distributed as most of the large, medium and small craters with the exception of Tilla and Nkwar Tilla are all located around the Miringa volcanic area which could be described as linear in pattern.

Socio-economic importance of the volcanic craters

The socio-economic importance of the craters depends on the type of the crater. It was reliably gathered during the group interview conducted in the three craters that the importance of the craters to the people include wood supply, livestock rearing, farming, quarrying, mining, tourism, traditional medicine, social importance, bush burning and domestic water supply. However, these important socioeconomic benefits are often derived in a way that create problems for the environment. The activities associated with the craters include the following:

(a) Wood Supply

One of the socio-economic activities benefits going on in the three craters, with Kumba craters being the most affected is the wood supply from the forest, even though it is reserved. Wood, is a major resource exploited from the forest for various uses by the local communities (group interview). It was observed and confirmed during Participatory Rural Appraisal (PRA) that it is used as a source of fuel (fuelwood) for cooking and other domestic needs. In fact, according to the group interview, firewood forms one of the major energy sources in the area. This finding agrees with similar researches, that some three billion people rely on firewood for almost all their household energy (World Resources Institute, 1996). For example, in Africa for every ten people, nine use firewood as the main energy source (Harrison, 1992).

(b) Livestock Rearing

Biu plateau is well known as a veritable livestock rearing area in the state. In fact, the Miringa LGA is one of the areas with the highest concentration of livestock population, especially cattle. It is one of the largest cattle markets in the area. Various factors combine to dictate the types, population as well as the spatial distribution of livestock over the Biu plateau. The environmental resources associated with the craters, notably, conducive climate, lush vegetation and water supply are very critical factors promoting the livestock rearing in the area. It was reliably gathered during group interview that the richest men in Miringa and Kwaya Bura were once cattle rearers. This agrees with the result of a similar research by Tukur, (1997), that grazing is the main land use on the Mabilla plateau, where most grazers have fairly large herd sizes consisting averagely of 60 heads per herd and it is not uncommon for a person to have 3 to 5 herds at a time.

(c) Tourism

The craters on the Biu plateau, according to the people of Tilla and Kwaya Bura during the group interview, provide them with micro climate especially during the dry season. The craters, especially the Tilla Crater Lake appears to have strong potentials for tourism and tourist related activities. Considering the geographical location of the craters in the southern part of the state and the spectacular altitude of more than 900m from the generally low plains, the northern part holds a significant potentials for tourist activities. It was revealed during participatory rural appraisal that each year they received tourists from Adamawa, Bauchi, Gombe, Kano, Taraba and Yobe either for tourism or site seeing. According to the World Tourism Organisation (WTO), reported in Mason (2003) more than 689 million people, about 10% of the world's population were involved in either local, national or international travels in relation to tourism in 2000. This accounted for more than \$575 billion, making it the world's number one export earner.

The Borno State Government is currently rehabilitating the existing housing units constructed in 2003, during the period of Governor Mallah Kachallah as well as constructing new additional ones all for the purpose of boosting tourism in the area as shown in Plate 2.



Plate.2: Guest House under Rehabilitation and construction in Tilla Crater Lake

Source: Fieldwork, 2014

If the government at all levels will harness the vast potentials associated with the Tilla crater through the provisions of infrastructural facilities such as tarred road, guests house, electricity, water and landscaping it will not only create job opportunities but also generate revenue. This will help in reducing the huge number of unemployed youth in the society.

(d) Enhanced Agriculture

All the three craters are volcanic craters with only Tilla crater that is filled with water throughout the year. The shape of Tilla crater could be described as pear shaped with size of about 900 by 700 yards of about 1, 000 acres in extent with steep sides rising some 130 feet above the sea level. To the East of the Tilla Lake is the Tilla Hill as shown in plate 3.



Plate.3: The morphology of Tilla Crater Lake

Source: Fieldwork, 2014

The respondents of the group interview and participatory rural appraisal conducted at Tilla crater lake indicated that the major sources of water to Tilla crater Lake is rainfall and seepage from the surrounding hills some of which apparently goes off through evaporation. Davies (1956) analysed the water of the lake and that of wells by the side of the lake and the result showed a higher concentration of sodium carbonates and sodium chloride in the lake water compared with that of sunk wells. This finding also agrees with the result of a similar research carried out by Adamu, et al (2012). That is why they could not use the water directly from the craters for market gardening due to its salty nature. Therefore, they had to dig wells on the shores of the crater. The people of Kwaya Bura and Tilla described it as a livewire for their livelihood because the Tilla crater holds water throughout the year. During the group interview, the people revealed that it boosts their sources of income. Mallam Adamu Mohammed, a member of the community stated that it is through the income generated that he built a three bedroom flat for his family with modern aluminium roofing sheet and bought grinding machine worth forty five thousand naira (#45, 000,00). Some of the people also revealed that they harvest about 10-25 bags of pepper (*Capsicum spp*), tomatoes (*Lycopersicum esculenta*), Okoro (*Abeimoscos esculenta*) and garden eggs which are worth up to fifty thousand naira to one hundred thousand naira (#50,000,00 to # 100,000,00) depending on the buying and selling situations. In fact, according to them they supply the bulk of pepper, tomatoes and garden eggs (*Solanum melongena*) to the Biu market and beyond. According to the Women, without the dry season farming, they would not be able to meet up with their financial responsibilities as housewives as revealed during group interview as shown in Plate 4.



Plate.4: Group Interview with Dry season farmers in Tilla crater

Source: Fieldwork, 2014

The respondents are of the opinion that government should assist by introducing fish farming in the lake. This will go a long way in supplementing not only their diets but also generate employment and income to the local communities. The people complained that they are faced with insufficient fertile farm lands on the shores of the Tilla Crater Lake. As such, government should assist them with fertilizer to increase their yield. Moreover, with the rapid population growth, the land is becoming scarce. A typical size of farm plot per person is shown in Plate 5.



Plate.5: Dry season Farming on the Shores of Tilla crater

Source: Fieldwork, 2014

Jali Tagurmi is the smallest crater among the three selected samples. The floor of Jali Tagurmi crater is extensively used for rice (*Oriza glaberrima*) cultivation since it retains water during the raining season while the outer slope is used for the cultivation of maize (*Zea mays*), guinea corn (*Sorghum*), pepper (*Capsicum* spp), tomatoes (*Lycopersicon esculenta*) and Okoro (*Abeimoscos esculenta*) during the raining season.

(d) Quarrying

Quarrying is another socio-economic activity going on in Kumba and Tilla craters as revealed during group interview. According to the people in Miringa, the Kumba crater is rich in pumice which attracts people from far and near to engage in the pumice mining business. The respondents also revealed that Ashaka Cement Company in Gombe State, carried out a survey in 2011 and discovered limestone in large quantity, a sample of which was taken for laboratory analysis. Plate 6 shows Youths in the area reclaiming back the sites from which the Ashakka Cement Company took their limestone samples for laboratory analysis.



Plate.6 Youths Reclaiming Ashakka Cement Limestone sample site

Source: Fieldwork, 2014

The Company promised the community that if the limestone turns to be of commercial quantity, the current road under construction from Miringa to Guda would be extended to Ashaka which will not only open up the area for commercial activities but also generate employment and income to the people of the communities. This will help in reducing the high rate of unemployment affecting the State and the nation in

general. Tilla crater is not spared from mining activity either as revealed by the people. The clayey soil of the crater is the target of mining in the area which is used for construction of houses. According to them, if they build their houses with the clay from the crater even without plastering, the houses last longer compared to clays from other sources.

(e) Supply of Herbs for Traditional Medicine

The Kumba crater, being a reserved area, has some species of trees that are not commonly found in the other parts of the Biu plateau. Therefore, people from far and near come to the crater to extract some herbs that are of medicinal value. Tilla Crater Lake is also not left out as revealed by the people during group interview. People come from far and near to fetch water from the Tilla Crater Lake for medicinal purposes. It is strongly believed that the water contains healing powers for diseases such as sunstroke, hysteria, epilepsy, insanity and other related skin diseases. This has attracted people as far as Kano, Bauchi, Yola, Gombe, Maiduguri and Abuja, the Federal Capital Territory.

(f) Overall Socioeconomic Importance

The Tilla crater lake had always been considered as unfathomable by the local communities until in June, 1933 when the Divisional Officer; Mr. Brandt, Government messenger Mr. Shettima Yikala and two CBM missionaries sailed across the lake using Canoe and found out the maximum depth to be about 5.2m with average depth to be 4.2m with the floor made up of soft mud and silt. The respondents revealed that there is a hole on the floor of the Kumba crater with water into which people use to throw maize corb and after some few days the corb will appear on a river called Thlamakwi in Gur Village which signifies time for harvest. This serves as a viable means of communication between the two communities. It also signifies a geomorphic phenomenon, the crater hole links with the source of the river.

The lake is also known to be full of crocodiles which are said to be of cream colour compared with those found in the surrounding rivers. The people said the crocodiles are sacred as they represent the “double” spirit of more than two clans in the area and the best time for seeing them during the day is 9 am to 10 am and 3: 30 pm to 4: 30 pm.

(g) Provision of Water for Domestic Use and Irrigation

The Tilla Crater Lake plays a significant role in the life of the immediate communities through the provision of water for their domestic use. However, the people confessed during group interview that they do not use the water directly from the lake due to the high content of Sodium chloride. So, they resort to digging wells on the shores of the crater as shown in Plate 7.



Plate.7: People fetching water and washing clothes on the shores of Tilla crater

Source: Fieldwork, 2014

Impact of the Socio-economic Activities around the Craters

Few, if any, areas of the world can be said to be free or unaffected by man’s activities but the extent of this influence varies. Although the problems posed by the socioeconomic activities to the areas around the craters are presented separately here, they are actually highly related in practice. They jointly lead to serious environmental degradation around the craters.

The magnitude and nature of these effects at the craters was obtained through direct field observation, measurement and group interview.

(a) Accelerated Soil Erosion

In addition to the geological erosion that has been operating on the three selected craters, there is also the problem of accelerated erosion induced by human socio-economic activities. From the three selected sampled craters, none is said to be free from human interference. Among the three sampled craters, it was observed that the Tilla Crater Lake is the most severely affected followed by Kumba which could be due to the presence of water throughout the year which attracts socio-economic activities all year round. These activities have accelerated erosion processes along the slope linking the Rim and the surrounding lowlands. Thus, these geomorphic processes have contributed seriously towards the modification and evolution of the craters.

(b) Deforestation and Biodiversity Reduction

As the forests around the craters are the sources of wood supply in the area this has led to indiscriminate felling of trees in the area. For each use of wood, however, there is a corresponding danger. The search for firewood is said to be one of the primary causes of deforestation in the developing countries Jimoh and Ifabiyi, (2000). The World Bank, (1993) argued that 15-20 million hectares of forest are being consumed annually in developing countries especially in semi-arid regions of the World. FAO (1982) reported that as many as 16 out of 45 countries in sub-Saharan Africa faced firewood deficits on part of their territory and could not meet their needs only by cutting trees faster than they are growing and reducing the stock. This has severely exposed the soil to geomorphic processes in the craters such as sheet, rill and gully erosions that has seriously contributed significantly towards the modification and evolution of the craters.

Similarly, the rearing of animals have resulted in overgrazing which has affected the vegetal condition around the craters. It was observed that this socio-economic activity has seriously affected the vegetal cover in and around the crater with Tilla crater being the most affected crater. This may not be unconnected to the fact that unlike the Kumba and Jalli Tagurmi craters that dry up during the dry season, Tilla crater retains water throughout the year, thus, it became an attraction to cattle rearers. It is therefore overgrazed and exposed to serious soil erosion.

(c) Negative Effects of Bush Burning

Bush burning which could occur either as a result of controlled burn, wild fire or deliberate burning has a negative impact on the environment in various ways. It was reliably gathered during group interview in the area that bush burning is a cheap method of clearing large areas of land for agricultural and other uses. It was also further revealed that local people around the three craters deliberately set bushes and forest on fire for the purpose of hunting animals such as snakes, bush rats, grasshoppers, grass cutters and antelope for consumption. Some farmers in the area are of the opinion that bush burning enhances soil fertility for crop productivity. The people seem to be ignorant about the negative effects of bush burning on the environment. Bush burning releases carbon dioxide (greenhouse gas) into the atmosphere. Bush burning is harmful and affects the quality of the soil. It results to loss of shade, micro- climate and soil moisture through high rate of evaporation. It was gathered during the group interview in Miringa that Kumba crater is a forest reserved area. Hence, people are not allowed to cut life trees, so people resort to set fire to the forest in order to have access and harvest dead wood for domestic fuel (Plate 8).



Plate. 8: Bush burning and Fuel wood exploitation in Kumba crater
Source: Fieldwork, 2014.

III. Summary, Conclusion And Recommendations

Summary : The study examined the analysis of volcanic craters and their socioeconomic importance on the Biu plateau, Borno State, Nigeria and come up with the following results: There are a total of fourteen craters on the Biu plateau with four falling under large category with diameter greater than three hundred meters, five fall under medium category with diameter ranging from two hundred to three hundred meters and five fall under small category with diameter of less than two hundred meters.

Socio-economic activities observed around the craters include farming, mining, grazing, deforestation, environmental degradation through bush burning, network of tracts made by man and cattle, fuel wood extraction and settlement expansion around the craters.

The study has revealed that Kumba crater is a reserved area that is used for grazing by the Fulani, illegal exploit of fuel wood by all, source of herbs for traditional medicine, hunting for bush meat, bush burning and extraction of local building materials. This has seriously affected the soil development processes in the crater as well as exposing the soil to geomorphic processes that contributed to the modification of the crater. The Tilla crater holds water throughout the year and the people of Kwaya Bura and Tilla described it as a livewire for their livelihood. The people revealed that apart from the lake providing them with micro climate, especially during the harsh weather of the dry season, it also provides them with water for dry season farming, drinking, domestic uses and animal grazing. Jali Tagurmi is used for cultivating staple food crops and vegetables all year round especially, within the floor and along the external slope, linking the rim of the crater with the surrounding area. Apart from these usages, the respondents also revealed that each year, they received visitors from Adamawa, Borno, Bauchi, Gombe and Taraba on field studies as the craters provide a good site with various features of interest that cut across different field of study and tourism. This has a great impact on the economy of the communities.

Conclusion: Currently, the results of the study revealed that in the recent past, the craters are not only subjected to geological erosion but also to accelerated erosion such as sheet, rill and gully due to the socio-economic importance of the craters to the people as a nuclei for livelihood.

Recommendations : Based on the findings of this research, the following recommendations are made: There is a need for a public enlightenment campaign at the grassroot to education the local communities by the local Government Authority on the environmental effects of their activities. This is to ensure sustainable use of the craters. Government at all levels should show serious commitment towards the development of Tourism in the Area through the provisions of infrastructural facilities such as tarred road, completion of the guests house, electricity, water and landscaping so as to boost Tourism. This will also create job opportunities apart from revenue generation to the local government and State.

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