ANALYSIS OF SEDIMENTATION AT WUYA REACH AND THE NEED FOR DREDGING TO IMPROVE CANOE TRANSPORT OF RIVER KADUNA, NIGER STATE

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BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF GEOGRAPHY BAYERO UNIVERSITY KANO IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN LAND RESOURCE DEVELOPMENT

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DECLARATION

I, Mohammed Ndanusa Usman with Reg. No. SPS/11/MGE/00061 hereby declare that this Dissertation has been solely conducted by me under the supervision of Dr. Adnan Abdulhamid of Geography Department, Bayero University, Kano. I have neither copied someone's work nor has someone else done the work for me. The information derived from the literature has been duly acknowledged in the text and list of references provided.

_____ _____

Mohammed Ndanusa Usman Date
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CERTIFICATION

This is to certify that this research work and subsequent preparation of the dissertation was carried out under my supervision.

_____ _____

Dr. Adnan Abdulhamid Date

APPROVAL PAGE

This dissertation titled "Analysis of Sedimentation at Wuya Reach and the need for Dredging to Improve Canoe Transport of River Kaduna, Niger State" by Muhammad Ndanusa Usman has been examined and approved for the award of Master of Science Degree in Land Resource Development.

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DEDICATION

I hereby dedicate this dissertation to my beloved family members (Mal. Usman Adam) and all my beloved friends

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ABSTRACT

This dissertation investigates some characteristics of the drainage/channel and geomorphological parameters of river Kaduna around Wuya reach especially the morphological shape of the reach, the slope processes that is explained by the fluvial activities in the channel and the space that is occupied by the activities. Measurement of the geometric variables of the river channel were carried out in six different catchments at two different seasons of rainy and dry periods involving samples greater than 30 samples which was subjected to pearsons product moment correlation r. Using the power of excel software computation with the r-value subjected to $z_{cal.}$ value which is finally Transformed into the z_{table} that allows for the measure of proportionate percentage decision to be inferred on the quantitative value of the reach depth that could be greater than the initial value measured to be dredged without much environmental compromises from the present /past sediment accumulation in the reach. About 120 correlations were established with four pixel structures values that elucidate the characteristics of the reach morphology. positive correlation were established among the parameters that were studied; 50% of measure of utility in decision needed for dredging was established, which has an average stream depth value to be dredged at initial depth id 5.07m in the rainy period from the present depth pd 3.38m depicting only 1.69m to be dredged or and the present depth pd value 2.742m from the initial depth id 1.83m depicting 1.052m to be dredged in the dry period. Sand patches or an island to be dredged that protrudes in the dry period in the river channel was calculated to be348.64343tone/km^2 /year. The exaggeration of the climatic 35years on ecological yearly feature occurrences of present past climatic geomorphology was computed at an average value of $12202.5201_{35years}$ tone/km^2/yr that translate to the accumulated magnitude measures a proportionate effects on human activities such as flood, extinction and suffocation of large fish catch due to low stream depth and slope distortion in the channel.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

In the study of sediment accumulation, there is the need to understand the process of channel morphology and its relationship with geomorphology and hydrology of the study area. The morphological characteristics of a river channel are dictated by its width, depth and cross-sectional area .The amount of sediment accumulation depend on these characteristics. The higher the yield, the wider is the channel. It should be noted, that geomorphology is an impediment to sediment supply and at times it augments the supplies. Although the erosive power of a river is invariably related with the velocity as well as its discharge volume. When the discharge sluggishes, the sediments are deposited producing rich flood plains, but when it is of high velocity, then errodability persists. Land form process analysis was contended by (Pareta and Kuldeep 2011). The hill slope and channel process was explained to depend on the timing of sediment transport in the stream flow process (Geoff and Ian, 1992). The scientific delay in probing into the fluvial river process over fluvial geomorphology was explained to encourage the researchers (Qazzi and Ashork, 2011)

The chain of relationship between hydrology and geology which is often referred to as hydrogeological relationships are important factors for both deposition and erosion of materials on the river beds. However, Mateo (2011) contended that the estimation and evaluation of stream flow process are the basis of fluvial control.

On Wuya, which is located at the junction of Mokwa-Bida roads produces a sediment fan on river Kaduna that requires studies. The river produces sediments which is quite extensive that hinder navigation to the area. The rich material is a potential resource that needs to be harnessed by both the Community and Government for the building industry.

In view of that, this study focuses on the area for canoe development. The formation of the sediment is however made up of aggregate of clay, silt and sand. The generation of this material

reaches an alarming rate through the fluvial process. According to the International Association of Dredging company, IADC (2006) asserted that the current practice for navigation channel maintenance generally include the placement of sediment removed to adjacent beaches which means Bankful empowerment. The proportionate amount of the soil-sediment excavation depends on the characteristics of drainage reach pattern and geomorphologic characteristics of the channel morphology.

It is also noted that temporal identity of stream flow has a great imprint on the channel morphology and flood plain especially during the rainy season from high storm (Yakubu 2010) therefore in the assessment of sediment accumulation, erosion activities in river flow, control all other parameters involved..Colin (1991) noted that fluvial erosion is caused by running water and some agents such as climate and slope process which has given rise to an extensive literature.

Canoe transport facilitates the use of ship and cargoes conveying people from one place to another, with their goods and services for socio economic development. Therefore, dredging of the sub-estuaries to remove accumulated fine sediment has received little consideration by government and individual.

Excess rainfall in the rainy season, sand- sediment deposition especially which raise the water flow level as a false reading level occurring together with land excess water spillage from Shiroro dam and sufficient saturated underground water, around the flood plain of Wuya reach makes the area prone to flood around the river channel.

Therefore, when there is an ecological distortion in the river channel there is flood, drought, sand/sediment accumulation among others. An empirical study will be needed to diagnose/assess the physical qualities of the river that has deteriorated, with quantified action to correct the anomalous in the river channel.

1.2 STATEMENT OF RESEARCH PROBLEM

Canoe dredging project for navigation to allow smooth flow of water at almost constant depth for the whole year round is an inevitable hence ecological problem that is initiated through river flow process will always set in. In other to provide better solution for the control of flood hazard especially during the rainy season, the soil generation and sediment accumulation along the channel in the lower Kaduna river that is triggered by erosion from Shiroro downstream system

which runs into Zungeru should be removed. The aim of the dam constructed on the Kaduna river at Shiroro is for electricity generation. However, its other objectives are to supply water for domestic uses and provision of physical and ecological flood control. Watershed and slope protection through the mechanism of sand-sediment dredging need would prevent delta shrinkage and meandering along the channel. Of course this may allow more excess storm to be carried when it is released from Shiroro dam either as water spillage or, through dam failure into the downstream. However, the Shiroro dam on River Kaduna has not adequately accomplished its role of flood control downstream sufficiently. Thus the need to dredge sand sediment on its lower course to facilitate long term solution to flood control in the area. However, To date, no suitable canoe dredging survey has been undertaken in the area. Thus both the physical and socio economic parameters shall be characterized separately and compared to ascertain its integrated cohesion among the variables of slope process, entrenchment ratio and patches of island deposition which can adequately decrease the rate of present flood that causes destruction to properties such as small feeder road that the flood occupies especially in the time of rainy season and farm land holdings for rice and sugar cane production, along the edges of the river channel that enhances the utility of water resources for irrigation farming in Wuya reach. Therefore, the followings sum up the problem statement as follows:

(a) an alluvial fan has developed at Wuya reach by enhanced sediment accumulation downstream of Shiroro dam which deposited to form the fan at the point of study due to some morphological characteristics of the river channel in the area

(b)The alluvial fan has reduced competence of water to transport water and sediment at the point leading to flooding at the slightest rise of river in the area.

(c)Both natural rainfall and water releases from the Shiroro reservoir give rise to such flood, thereby making one of the objectives of constructing the dam control of flood unachievable.

(d)It is importance to dredge the river at this point by removing the alluvial fan to control the flooding by making the river flow freely

1.3 AIM AND OBJECTIVES

The aim of this research is to analyse sedimentation and dredging needs for canoe transport at Wuya reach of River Kaduna.

The specific objectives are:

i. To characterize the different channel morphometric indices in Wuya reach.
ii. To determine the volume of sediment deposited in Wuya reach.
iii. To estimate the volume of sediment to be removed from the river to facilitate canoe navigation and reduce flood.
iv. To investigate ways of remediating future sediment accumulation at the reach.

1.4 STATEMENT OF RESEARCH QUESTIONS

The research question suggested flood hazard in the rainy season and extinction of canoe transport development due to sand sediment accumulation over dry season period. The following summary defines the questions such as:

a. What are the morphological characteristics that encourage sedimentation at the Wuya river banks?
b. How much sediment has been deposited in the river channel?
c. what the ways to encourage smooth and free flow of water in the river for navigation and reduction of annual flooding?
d. What structures and measures should be used to prevent future sediment accumulations at Wuya?

1.5 SIGNIFICANCE OF THE STUDY

The need for the removal of sand -sediment from the river channel can enhance the Mineral sand for road construction and cement factory raw material hence calcium carbonate can be found around the reach. The socio economics of hotel location activities for recreation and tourist center can discourage foreign picnic abroad and conserve our foreign exchange capacity for the nation. Joy and Greg, (1992) observed the objective of the dredged work throughout is to illustrate the effect of human impact on the main ecosystem physical component. The dredged river channel keeps animal and plant ecosystem without exposing them to suffocation due to the low rivers depth that discouraged the large fish abode, it allows the turbidity of water to be reduced, hence sediment settlement, immediately after its removal, it can also save life and properties during the dam failure hence more storage capacity of river can be enhanced and it can house large cargoes with other canoe services such as direct route of ferry navigation as against

the present backdrop navigation of been zig zag hence sand-sediment generated only immediately after a torrential rainfall. Fluvial resource, if properly maintained could yield high rental value that serve as an alternative transport investment.

1.6 SCOPE AND LIMITATION OF THE STUDY

The parameters and variables were restricted to slope measurement, flow rate, depth of the water, and the need for dredging to facilitate navigation and better the condition of the riverine settlers in relation with their environment and to mitigate negative impacts of sedimentation. Some of the variables were studied in both the rainy season and the dry season: the rainy season in August, September and October and the dry season in December, January and February. The research does not collect data on flood indices, social cases of accumulation mishap, sudden disappearance of drowned people due to high turbidity in the river. The collection of data took place at six spatial settlement sites namely Kpayi, Dogbe, Wuya Kede, Wuya Kpata, Emiyamiworozhi and Evugi.

1.7 JUSTIFICATION OF RESEARCH AREA

The conception that the water discharge from Shiroro dam started the gradual flooding problem in this riverine area and it started erosion problem which triggered siltation consequently causing sand- sediment deposition in the river channel which reach its peak in the rainy season. Thus during the rainy season, siltation in the river is an issue of great concern since it generate patches of island as sand/ sediment in the dry season hindering canoe navigation, siltation blockages that triggers flood in the reach with canoe inefficiency was a challenge that needs an urgent attention, especially with the present survey work at Wuya reach on the characteristics of the river channel morphology; which was categorized as Drainage / stream channel and geomorphological characteristics .

1.8 BACKGROUND OF WUYA STUDY AREA

The area is located in the northwestern part of Nigeria in Niger State (Figure 1.1). the general activities of the people are mostly fishing and farming. The area is bounded by latitude $9^{0}\,05^{1}43^{11}$

N to $9^0\,04^1 03^{11}$ N and longitude $05^0\,48^1\,59^{11}$ E to $05^0\,48^1\,06^{11}$ E (figure 1.2), the location for each site with its economic activity was depicted as follow (Table 1.1). It is a tributary to the River Niger on the lower confluence of Muregi.

Table 1.1 Location site with its economic activities

Serial No.	Sites	Location	
		Latitude	Longitude
A	Evugi	$09^0 48^1 39^{11}$	$05^0 48^1 39^{11}$
B	Emiyamiwozhi	$09^0 06^1 41^{11}$	$05^0 49^1 22^{11}$
C	Wuya kpata	$09^0 06^1 26^{11}$	$05^0 49^1 18^{11}$
D	Wuya kede	$09^0 06^1 02^{11}$	$05^0 49^1 07^{11}$
E	Dogbe	$09^0 05^1 43^{11}$	$05^0 48^1 59^{11}$
F	Kpayi	$09^0 04^1 21^{11}$	$05^0 48^1 51^{11}$

Source:: fieldwork (2013)

The area ranging around the riverine into the mouth of River Niger which is the final stage at sand deposition region, due to the erosion material from the upper course of Shiroro water dam through the middle course of Zungeru water in the river flow; the study area cover around $64km^2$in the river channel and its immediate boundary, which include the river channel from Kpayi settlement to Dogbe village through Wuya Kede along Wuya Kpata settlement to Emiyamiwozhi to Evugi. It is suggested that, the Lower Niger below its confluence with the Benue consequently has a high-water period that begins in May or June and a low-water period in at least a month shorter than on the Middle Niger, because the rains in the south start earlier (Inger, et al 2005) while it is bounded by, west and east of Kutigi and Bida. The predominant work of this area is fishing without replacing and farming .. Google base map (2014) shows the study area where each site along with their appropriate latitude and longitude (figure 1.2).

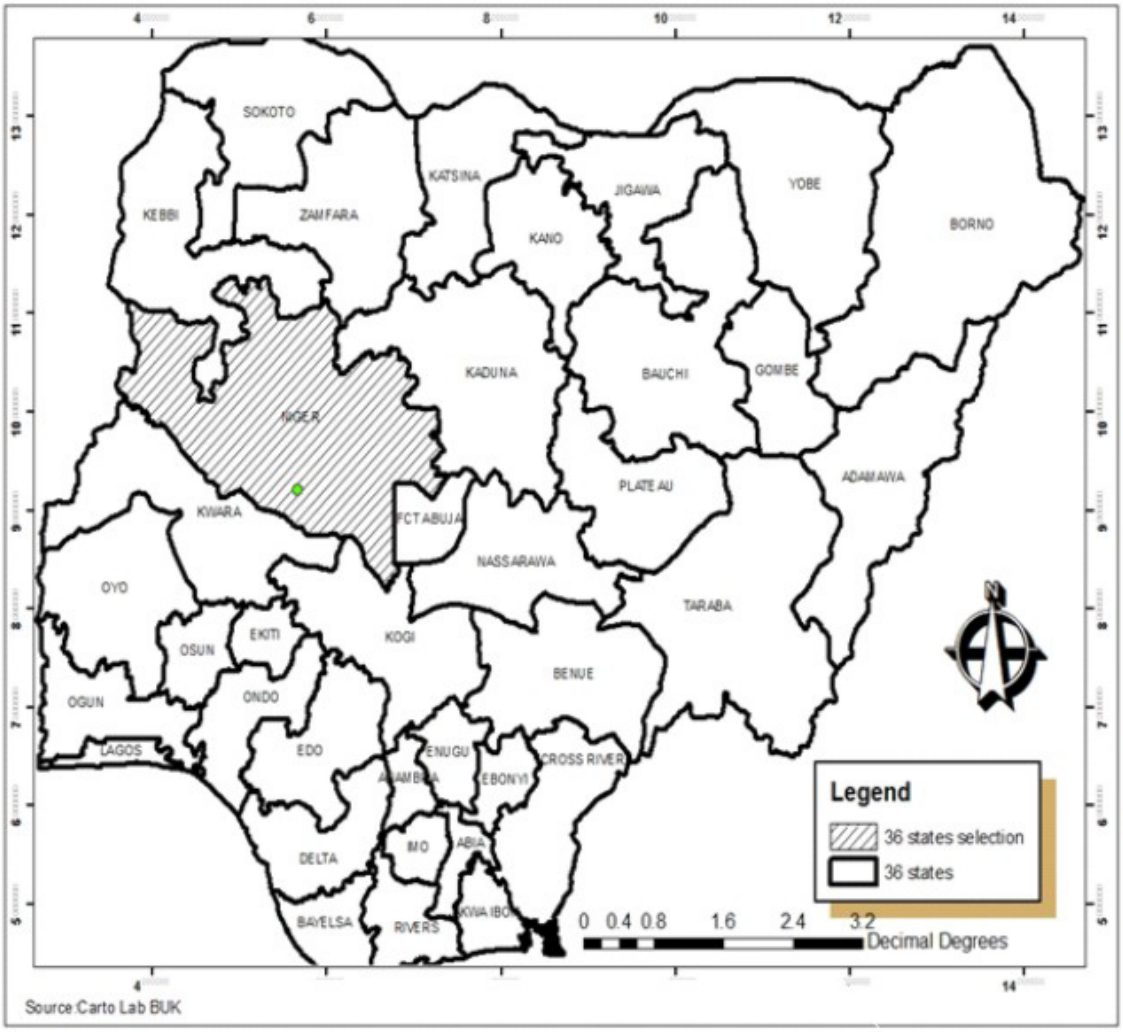

FIGURE 1.1 The study area in Niger State

Source:: Google base map (2014).

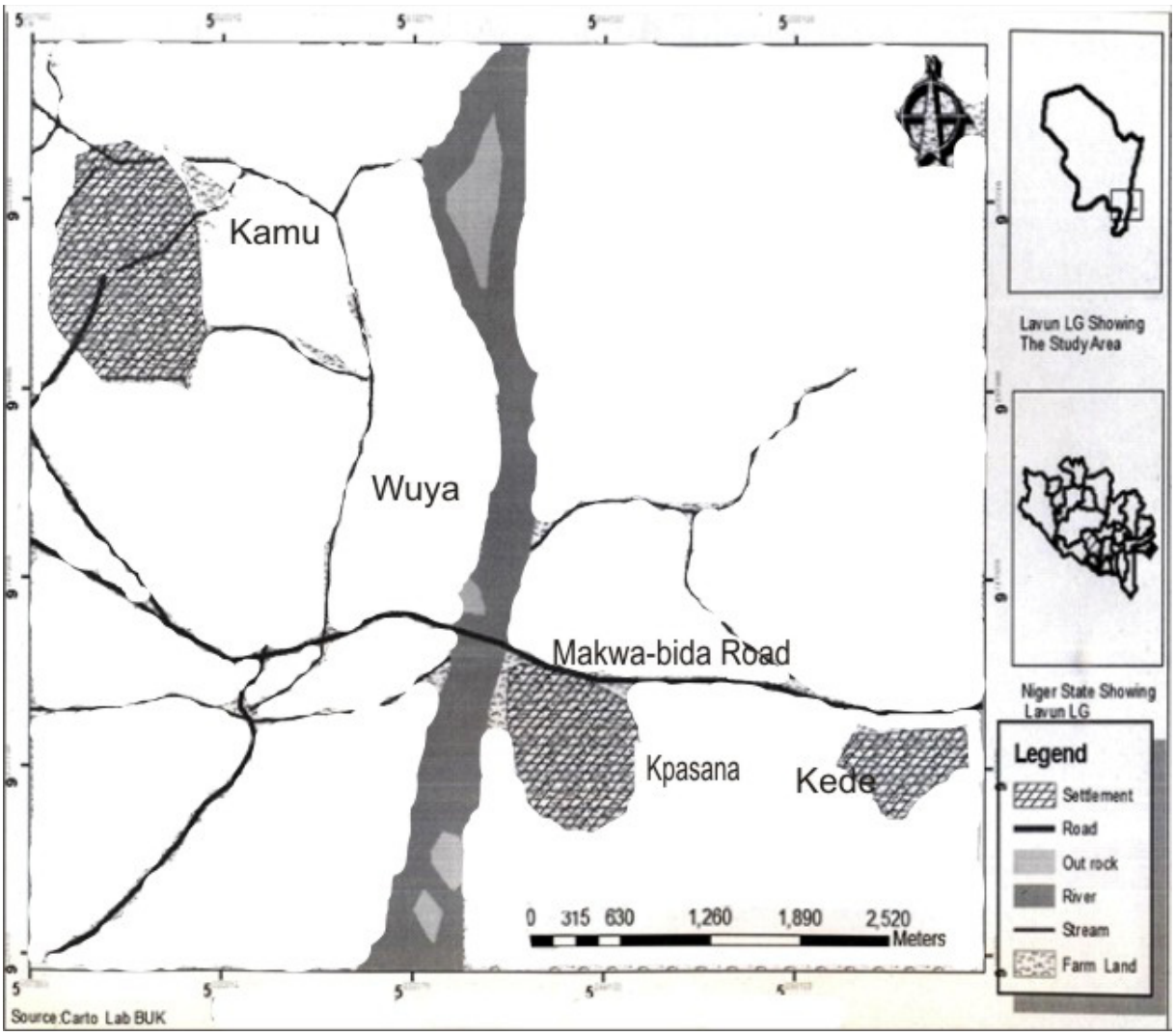

FIGURE 1.2 The study Area in lavun local Government

Source:: Google base map (2014).

Table 1.2 Average climatic condition of Bida around Wuya reach.

Month	Mean temp 0^c c	Range 0^c	Rainfall mm	Evaporation mm	Relative humidity%	Wind run m/s	Wind direction
January	25.5	19	26.7	4.0	50	31.15	NE
February	27.7	17	-	6.0	62	62.13	NE
March	24.5	19	-	8.0	65	92.91	NE
April	31.0	8	20.2	8.9	63	135.98	SW
May	28.5	7	210.1	7.0	78	116.45	SW
June	27.5	7	169.4	5.0	83	92.12	SW
July	26.5	7	238.4	4.0	85	89.92	SW
August	26.0	6	151.7	4.0	85	107.12	SW
September	27.0	8	162.8	4.0	85	83.82	SW
October	27.5	4	72.9	6.0	84	64.28	SW
November	28.0	14	36.0	5.0	67	38.69	NE
December	28.5	19	_	4.6	54	32.02	NE
Mean Year/total	25.25	12.42	90.683/ 1088.2mm	5.37	71.75	87.42	

Source: Adopted from N.C.R.I (2013)

1.8.1 Soil, Vegetation and Climate

The area is geologically of basement complex origin and share the central basement of northern plain mixed with derived materials from wind drift that covers the regolith of the ancient rock of igneous. The nature of the good soil of ferruginous type with the Hydromorphic soil that contains iron in the reach makes it possible for socioeconomic to take place, especially farming and fishing. The region is part of the tropical climate with wet and dry nature which is a guinea savanna type. the (Table1.2) depicted summation of the climatic condition has a mean daily *25.50*C, with annual range of temperature*12.420*C signifying the proximity to the river, The mean rainfall was computed at 90.683mm. While the total annual rain fall is 1088.2mm which fall between January and November with the highest rain storms in the month of July that reach

up to 238.4 mm (Suleiman et. al., 2014). The Guinea savannas rainfall extends to 6-8 months which has significant amount of storm from 1000mm-1500mm.

Olofin (1987) observed that temporal variation in rainfall was due to the climatic condition with the four distinct seasonS which is also peculiar to our study area. Evaporation is low in the study area. with the average scale at 5.37 mm, depicting that Wuya reach has much underground saturated water which has a wind direction at SE trade wind, signifying the rain bearing direction from the south monsoon at the average wind run at 87.42 m/s; which depicts how the wind can change the river flow movement and even the sediment that can be generated at a given period of the season.

1.8.2 Geology, Relief and Drainage

The underlain pre-cambia basement rock consist of granites of genesis, with local relief of 91.29m above sea level which serve as temperature inversion for higher temperature cooling condition ; the highest elevation in the reach indicate 132.07 m which corresponds to the lowest elevation of the reach at the value 74.5 m. the average slope in the rainy season was scaled at 0.0283, while in the dry season the slope was scaled at 0.002.

The major river in the area is zungeru river or River Kaduna which is called Lavun (turbid) in Wuya reach and River Niger at it mouth around Muregi where dendritic pattern up to Patigi where River Kaduna and River Niger meets via Lokoja where River Niger and River Benue meets. The average depth in the reach was measured in the rainy season is put at 3.38m, while depth indicate initial depth (id) 1.83m at dry season ;although the reach has an average area that was prone to flood at the scale of 110.482 m from the river channel.

1.8.3 Socio Economic Activities

The population of the area is estimated at around 4500 people which consist of the indigenous Nupe, the Fulani cattle rearer, Yorubas and Hausas. The occupation of people includes fishing without replacement in derelict ponds, sugar cane irrigation farming, rice irrigation farming and local cattle range market, where the Fulani brought out cows for to couching the effect of their hard time; Hunter goes after animal hence the water zone serve as hot spot for animals drinking zone anybody traveling from Abuja through Bida-Jebba road can serve as picnic and holiday

resort area. According to Evans J.T (2006) the case of Tourist development in the Italian–cook Island hotel Accommodation serves as evidence in the environmental improvement for the surrounding indigenous people if not dominated by bad government policy. The historical background of the area is the Kede people (Riverine people) in lavun local govt. whose work is that of fishing and farming of sugar cane and rice among other farming activities. moreover; due to the overturn cases of sudden disappearance of the drowned people; Hausa people from Argungu in Birni Kebbi has taken up fishing industry, thus selling them to the indigenous riverine settlers for smoking and final marketing and distribution, although little fishing practices is still been observed by the riverine settlers, these Hausa people also paddle canoe using long route in avoidance of sand-sediment accumulation in certain patches along the river course in search for fishes especially in the dry season and sometimes the Hausa settler embark on rice cultivation at the bank of the river ; however, commercial canoe activities using canoe is strictly restricted to the settlers, unless in emergency cases were they allowed the Hausa commercial canoe activities to bridge the water transportation in the reach ; the settler establish the right to navigate the River for commercial purposes in the day time but when it is in the advent of flood all the settlements around play equal role of emergency need to navigate the people at risk especially the children and women, although when it is night, the indigenes canoe is not available, paving way for the commercial use of the boat by non-indigenous canoes to navigate the river for other commercial purposes including the carriage of farm product from the interior settlement such as Evugi and Kpayi .it was noticed in the reach that the economic value of the sand generated within the river flow is been excavated out for the ongoing road construction from Bida to Mokwa which is at its the initial takeoff as a development project.

CHAPTER TWO

LITERATURE REVIEW

2.1 INTRODUCTION

Scientific method of measuring the fluvial landscape is systematically introduce to integrate geomorphological and fluvial indices to explain the theories and law governing the nature of fluvial land behavior due to erosion activities that shape and modified the quality of how the original land study can be interpolated and extrapolated from the study of past works to allow for the gaining of more insight into setting of a better frame for the development works that can be initiated for the betterment of people in the immediate environment of Wuya reach, the local government, the state and Nigeria as a whole .

2.2 CHANNEL MORPHOLOGY

2.2.1 Source of channel River Discharge

The source of River Kaduna got its origin from Jos Plateau flat table sedimentary rock Mohammed, (1998) remarks in his work that this River has two major tributaries namely River Sarki pawa and River Dinya which spill through Shiroro reservoir downstream through Zungeru to Wuya Reach. Qazzi and Shork (2011) defines channel morphology as the shape of the channel either single or multiple stages along River flow Discharge..Jacob (1994) noted that fluvial process of abrasion, corrasion, evorsion and hydraulicking combine to shape the channel development, however the method of abrasion and corrosion is more efficient in channel shaping tendency.

2.2.2 Channelization process

Channel formation from Jos Plateau source in addition to storm downpour combine with River Sarki Pawa and River Dinya started the channel process of river Discharge in River Kaduna. Olanyan et. al., (1999) noted the Aspects of water management in the Badegi rice irrigation

scheme: Problems and Prospects, the objectives was to assess the economic and topographical constrains that depend on the success of rice irrigation thus slope variables were measured and studied that could enhance the irrigated land to follow the stream flow pattern systematically (channelization), they recommended awareness to the farmer among other recommendation to argument the effect of the dry season. Waheed et.al., (2010) asserted that the Impact of Urbanization on Kaduna River Flooding was expanded by their explanation of population growth, urbanization and expansion of structural development into the tradition flood prone areas in the urban expansion quest for structural construction to ensure a better response to flood issues are addressed, Waheed et.al., (2010) also noted that Over 85% urbanization was attained in the reach 1 among other reaches studied the reason that was advanced was that of Bankful flow capacities, they suggested and recommended probing unto River flooding, Geomorphology and flood plain development, they emphasized the rainfall data analysis, flood frequency analysis by the application log Pearson type, geomorphological characteristics and channel planform classification .

2.3 GEOMORPHIC MAPPING OF RIVER

The primary objective of channel survey is to measure parameters that contributed to the sediment generation within the river discharge, the discharge rate that can trigger sedimentation was surveyed to allow for sediment data that computed to dredged sediment in the channel which enhance canoe free navigation for social economic advantage in the reach. Qazzi and Ashork (2011) observed that the stream channel has 0.0442 m/m, while the reach slope has 0.0423m/m. Anthropogenic sources were seen to be the major causes of the decrease stream flow, thus a more excavation in the stream channel will allow more of water impoundment, which can cater for the water shortage in the region. USGS (2014) demonstrated how Stream Flow is Measured using the river flow velocity with the area of stream flow Joy et. *al.,* (1992) asserted that the objective of any survey throughout is to illustrate the effect of human impact on the main ecosystem component and how the physical process affects man survival Channel survey of channel area and depth was targeted during Rainy season and Dry season, comparism of these two temporal identity set up standard in the channel sediment accumulation in relation to how much river flow discharge can set the pace of sediment process. The model formula used in the survey was that of Fournier (1960, cited by Hugget 2011), it was compared to that of Milliman

and Mead (1983, cited by Hugget 2011) that investigated the chemical and mechanical denudation of the world continent, where Africa data was used to validate the present survey in the reach.

Bathymetric survey which is based on the depth estimation at a particular latitude and longitude of each sites in the reach was important hence the survey measured both depth in both Dry period and Rainy period.

2.4 CHANNEL GEOMETRY ANALYSIS

Morphometric indices, forms the basis of geometrical study in the process and form of channel formation and sediment accumulation. Qazzi et al (2011) assess the classification of Doodhganga stream in Kashmir Himalaya, India. he studied the stream channel morphology, classifying then into the Drainage reach /stream channel and geomorphological characteristics, he observed a decrease downstream in the stream channel due the stream diversion for the irrigation agricultural practices and also due to domestic water extraction on the temporal march to June (spring) and December to February (winter) is observed, Mohammed, (1998) highlighted the quantitative analysis into some morphometric variable in Shiroro reservoir upstream, Mohammed, (1998) remarks in his work that different morphometric indices of shape, size and space in the dam, the variable were classified according to the dam morphometric characteristics /Hydro sub system variables, The mean (x), standard deviation (s) and coefficient of variation (cv) was worked out, in each variables. Mohammed, (1998) noted the interrelationship among the variables using the correlation matrix in the principal of component analysis that was subjected to the student t- test at 0.01and 0.05 confidence level; correlation structure diagram which shed more light on the strength of relationship, the analysis of the cohesion among the variables measured due to the strength which is strong and less strong to the ascertain the variable that can be mitigated and those that may not need mitigation, before any proper and meaningful development can be achieved, Mohammed, (1998) recommended that sediment that was generated to be disperse periodically in other to disallow the false level reading in the dam crest; this should be done especially by the indigenous civil engineer to prevent capital flight to foreign company which increase foreign exchange capacity of the nation, discouraging capital flight from the country.

2.5 SEDIMENT TRANSPORT

River water transport initiated fluvial process that triggers sediment accumulation process. Zakari, (1985) assess the quantitative explanation into the indices of errodability in emiko reach, he measured and probe into errodability indices that trigged the impact of flood hazard in the reach, the variables was characterize by soil lost equation which was work and evaluated which allows a better insight into fluvial process as created in the channel morphology and soil generation into emiko reach ;which suggested the cohesion between the channel process and slope factors, reach shape morphological indices and the reach perimeter among the indices that was surveyed for the study area. Obansa (2010) noted that the spatial and temporal patterns of water and sediment transport directly influence the geomorphology and biochemistry of a river

2.6 SEDIMENT YIELD

Sedimentation is process sediment deposition where the channel or a reservoir tents to sluggish in its river flow course there by mass wasting vertically and horizontally along the channel or and Reservoir. Evans (2006) noted that the factors causing the deterioration of Rarotongas reef lagoon was sedimentation, she asserted that studies by different researchers like connel and Howker (1992) investigated that the average sediment loads of 160 to 200mg/cm^2/day was evident in the Rarotonga reef. Brandy and Well (1999) noted that detachment of soil particle, transportation of the detached particle and deposition of transported particle marks sediment accumulation. Tarawreih, (2009) remarks that Water and Sediment Yield for wala Dam Catchment Area occupies the upper part of Almujib Reach, Jordan with Mediterranean climate,, he noted that the dam was constructed for underground recharge purposes, recognizing the threat of water and soil loss with subsequent sedimentation problems, he employed the technique of soil and water assessment with GIS Application to simulate the hydrology, soil erosion and sedimentation of wala dam catchment. Tarawreih (2009) observed that the curve number method, rational method and the universal soil equation USLE and modified USLES model, Rainfall data were not exceptional. The monthly and annually simulation were employed, surface runoff, soil erosion sediment and water yield.

Brownlie and Brown (1978) remark on the review of sediment deliveries, it is noted that the long term sustainability of California's beech depend on periodic deliveries of sand and gravel from

coastal rivers and streams; this depict for any beeches to standstill, a periodic /regular dredging must be accomplish as a physical /ecological solution to the regular washing away of 0ur beeches. Jacob (1994) investigated the work on the morphology and Hydrology of Ngada catchment and Bama Beach Ridge. Using the technique of remote sensing to convey a mean annual suspended sediment yield of 2.0 x10^6tones/km^2//year, which threatens the life span of the Alau reservoir through excessive sedimentation. Jacob (1994) suggests the need for dredging in the Alau reservoir regular or and periodic excavation. Ismail and Iyortin (2013)remarks on the Application of Remote Sensing and Geographical Information System in flood vulnerability mapping: A Case Study of River Kaduna through varying location and varying magnitude which has an imprint on the environment especially on the floodplain, human properties and distribution of their socioeconomic such as transport and communication Ismail and Iyortin (2013) asserted some cause factors that triggers flood such as land inundation from heavy rainfall, climate change and blockage of drainage with refuse, construction of building across the drainage among other flood cause factors studied. Ismail and Iyortin (2013) remarks on the technique employed includes presentation of flood hazard map, digital elevation model and simulation of flood flow at different return period. The dam was reclassified into region of high risk and region of low risk and vulnerability maps of the area prone to flood was produced. Interview conducted to respondents shows 58% awareness to the risk posed by the flooding before setting .They concluded the study giving recommendations among which is the use of sand bags to elevate the terrain from flooding to some degree as an ecological solution. Also, McCauley (2001) investigated the Ecology and Politics of large Dams, he pointed out that the impacts of the Rivers has a complex ecological occurrences such as flood among other sudden event which are certainly impossible to predict correctly. McCauley (2001) remark on theories that explain ecological dynamics of rivers are mainly based on the short term studies of small temperate watershed .He emphasis the main categories in the environmental impacts dam has: 1- Dam construction period 2- Dam operation period

McCauley (2001) noted the Two Swedish ecologist that had estimated the degree of damage to river system in the U.S, Canada, Europe, and former USSR Mats Dynesiun and Christer Nilson of the University Umea found that fully 77% of the total water discharge of 139 largest river system in this countries is strongly or moderately affected by fragmentation of the river channels and water regulation resulting from reservoir operation, inter reach diversion and irrigation .As a result of habitat destruction and obstruction to organism dispersal. Dynesiun and Nilson

concluded many river species may have become extinct over vast area. others may become fragmented and run risk of future extinction.

2.7 DREDGING ACTIVITY

Jacob (1994) suggested the need for dredging in the Alau reservoir at regular or and periodic excavation. Amina, (2006) highlighted the environmental evaluation of Tiga dam, he identify the extent of dam project impact through the use of interview and other sources. she characterize this impact into social impacts, economic impacts and the environmental deterioration due flood, sand /sediment accumulation in the downstream and the danger of undispersed sediment in the upstream of Tiga dam which needs a periodic and regular sediment dispersal, the work recommend among others, the periodic /regular dispersal as sustainable vision for Tiga dam development resource. Gopinath (2008) probes into the Construction of Environmental Knowledge he contended how sustainable development can be achieved in the third world countries using the knowledge of the environment in which the issue of ecological occurrences is one that need special attention. the study indicate how development could be achieved using the information and flood data issues and land degradation record/inventory. Deltares (2014) demonstrated the Beneficial Re-use of Dredged Material, the article is how to direct the reuse of sediment as an essential, integral and dynamic benefit for man use. Sediments are derived from the weathering and erosion of mineral, organic materials and soils while dredging is essential for maintenance and development for water ways and harbors, Tarawreih (2009) suggested two prediction scenario were performed both indicate that western and northern sub reach yield more water to the dam and are susceptible to erosion and sediment .his study recommended the soil conservation and sediment reduction (dredging). Deltares (2014) noted that dredging are also necessary for navigation remediation and flood protection. The methodology employed includes classification of benefit or re-use of dredged material:

1. Sustainable relation in the estuary
2. Erosion control of soil onshore
3. Erosion control of soil by sediment removal and deposition by the beaches
4. River bank erosion control by using reed reinstatement
5. Ripening of dredge materials

He concluded that since coarse materials re-use is significant more than the less soft materials re-use he suggested studies to bridge the information of re-use of less soft materials

Yusuf et. al., (2004) assessed Fluxes in suspended sediment composition and the total dissolved solid upstream of Galma Dam, Zaria, he identify sediment composition and the total dissolved solid upstream of Galma Dam. The method adopted in the research was the use of systematic sampling techniques, the use of velocity and cross sectional area of flow computation. Yusuf et. al., (2004) remarks that the width of the river and its depths was measured sediment. They adopted the data analysis of logarithms transformation. Yusuf et. al., (2004) demonstrated how log transform data were plotted against distance upstream to review their upstream trends. Suspended sediment and total dissolved data were separately correlated, student t test was also employed to test the significance of correlation coefficient of variation and range for each variables. The result and the discussion of the work employed descriptive statistic data in sediment concentration (suspended sediment and dissolved solids) total dissolved solid was between 120mg/L and 1400g/L with coefficient variable 76 percent mean solid discharge 4.41g/s with sd 3.62g/s they compared the suspended sediment concentration in Galma reach as low to that total dissolved solids with mean of 220.8mg/L to 508mg/L Yusuf et. al., (2004) they concluded that the study of sediment concentration and discharge fluxes to be an important and useful in the municipal water supply. John (1987) investigates the State, Oil and Agriculture in Nigeria. He noted how policy could direct the sector, if problem among others stand as impediment to agriculture is resolved. He enumerate problems of flood, unsuitable technologies for local ecological problem however, he suggested traditional system to assist in the monopoly of western information system he gives example of kwaras, (the Lebanese) that dominate the sphere of economic development to the determent of the indigenous, he concluded the research work by enumerating draught solution, flood solution and indigenous participation in development of this natural resources.

Abdrahman. et. al., (2012) assesses the river pollution by the traces of industrial and household and pharmaceutical and greater demand for Water, they observed the reactor become biomass active at very low concentration of the target organic for efficient removal of toxic traces in the Water. Studies were carried out several residence time analysis and PCP analysis with its metabolite resulting in the removal of the chloroogarnic biodegrading via reduction discoloration that was made possible in the auoxic buttom layer of the bioflux. However suspended sediment

was not the target in the studies. Angerer et al (2003) investigated reforestation of tree plants could enhance fluvial efficiency in the reduction of sediment yield in the stream flow, Exploring the potential impact of reforestation on the hydrology of the upper Tama river catchment and the wasaga dam, Kenya they employed reforestation to decrease evapotranspiration in the stream and increase its relative humidity thus creating umbrella shade to the stream consequently improving the sustainability of the stream flow regime in the Tama river which discourages siltation of sedimentation in the dam, that introduce erroneous water level in wusaga dam for budgeting domestic uses and agriculture irrigation programmers however, the paper recommended a sustainable forestation to the upper Tama catchment to reduce sedimentation in the river flow. Haggitt et al, (2008) investigated the sand mining environmental issues associated with the sand extraction environmental information survey on the Kapaira Accumulation Marine Environment, he related the frequency of dredging to the volume of sand been extracted, and the physical characteristics (sub strum and water column of the dredged area suggest a good way into the sand dredging need estimate, they identified the critical gaps that are critical to integrated management. Haggitt et al, (2008) demonstrated that the study shows the vulnerable activities carried out in the adjoining catchment which includes:

i. Long term plans for catchment development
ii. Changing pattern of land use,
iii. The effectiveness of current plans, policies, among others ;
iv. Ecological change that would provide feedback on policy effectiveness,

The current scale and magnitude of sediment related effects and the long term cumulative impact of sediment and contaminant runoff.…Time series monitoring is undertaken in the kaipara canoe for state of the environment assessment for the water quality` and quantity.

James et. al, (2007) asserted in their proceedings of coastal zone on where is the sand? Reduction in the delivery of sediment to coastlines reviewed the anthropogenic activities reduce sediments to the coast by altering the processes which supply sediment to the coast. James et. al, (2007) suggested the need for sediment dredged from the inland to the coastal buffer zone of the channel river flow, in this way the channel morphology will maintain its coastal boundary instead of the erosion lashing backward, thus a distinct channel shape will be encouraged and maintain; however, the human mitigation process that reduce the sediment should be in line with need,

with the environmental norms without much tempering with ecological zone of both the animal /plant families. Inger et. al., (2005) observed the trend in the Niger river reach, a vision for sustainable development they observe navigable river segment, transport of suspended and dissolved solid material, ….the annual TSS transported in the river Niger, result from water shed erosion of stream beds and bank which varies between 0.7 million tone to 2million tone, depending on the river flow and on the topic Hydrology, hydrogeology and the over view of data management Inger et. al., (2005) suggests a great deal in the non-availability of both spatial measurement in size, space and quantity in geomorphological parameters.

Also, Huggett (2011) suggested a formula relationship for sediment yield with almost three constant values accounting for their correction factor, Fournier (1960cited by Huggett 2011p87) uses sediment data from78 drainage basin correlated suspended sediment yield with a climatic parameter according to the available data thus making the equation a standard and universal fluvial formula, although it is long, but its relevance among researchers is unique.

 -tan) this universal equation that relates the climatic condition of rainfall in the stream flow with its relief morphology. However he did not consider other factor such as physical denudation process.

Finally, Mohammed (2011) assess the environmental audit report using questionnaire as a base for its data generation, the survey noted how to understand people's perception on the socio economic activities in the shiroro environment. He highlight the performance of shiroro dam project on the social integration in relation to project success and the economic success in relation to projects development before dam's inception in comparism with development after the dam project was initiated, which identifies major achievement in development cohesion between the pre dam and post dam era, Mohammed (2011) highlights the variable that needs mitigation and those that did not mitigation .hence mitigated variables allows for more developmental tendency, in an extra fluvial civil engineering using the geo/physical parameter that were generated by the river flow in the channel morphology, measured by the scientist in the field of hydro geomorphology

CHAPTER THREE

MATERIALS AND METHODS

3.1 INTRODUCTION

The contents of this chapter include methods carried out in the field study. These include the materials used in the field measurement (both in the reconnaissance survey actual field survey), Drainage/stream channel variables in the reach, geomorphological variables in the reach together with the estimation of sand dredging in the reach are explained. Data estimation types, data estimation sources, data estimation using different techniques, data estimation importance, data estimation effect and data estimation problems were considered.

3.2 EQUIPMENTS AND SOME SOFTWARE

3.2.1 Garmin 76 CSX Hand Held GPS

Hand held Garmin 76 is an instrument used to measure coordinate point, distance, decimal bearing of a point among other uses that was exploited. It was used to generate data in the survey that include the coordinate point of sediment yield depth, site bearing elevation and site slope

3.2.2 Sufer 11

Sufer it is software used to convert decimal bearing to latitude and longitude, drawing contour and mapping of the study area. Sufer was used in the survey to convert decimal bearing of different sites into longitude and latitude at the different location in the reach.

3.2.3 Current Meter

It is an instrument used to measure the velocity river flow at moderate deep depth spot without rendering into the sediment. Researchers like USGS (2014) demonstrated how Stream Flow is Measured using a Current meter. The velocity is worked with the river flow area to allow for River discharge value within the channel.

3.2.4 Ranging Pole and Levelling Staff

It is an implement use to establish an initial point of reference along linear measurement and the final point in a survey, while the leveling staff does the same linear adjustment in the measurement

3.2.5 Measuring Tape and Gage Staff

It is an instrument used to measure linear distance in meter while Gage staff is an instrument used to establish specific position in river channel.

3.2.6 ARC GIS 9.3 Version

It is an cartographic software used to plot conventional map, contour map among other measures that can the accomplished by this software. It uses the base map from the study area to be map proofed by the software.

3.2.7 Auto Cad Excel Version

It is an excel software used to refined the few data measured in the field resulting into more derived variable

3.3 METHOD

3.3.1 Type of Data Collected

The Sources of data are the two basic different sources which depicts where are derived and obtained:

a) **Primary Sources**

The sources of data are sources utilized by researchers to generate the primary data such as field observations, measurement and casual interviews especially on the measurement of the area prone to flood in the floodplain in the settlement sites.

b) **Secondary Sources**

These are published and unpublished existing material from which the researchers gather some information and or refined data. These sources of data were the main concern, which was basically initiated from the library resource search. Academic journals printed out from

internet, newspaper relating to the study area with information on flood issues, sand/sediment generation, Canoe transport accessibility, dredging works and alluvial plain irrigation farming among other issues. Map was also consulted and relevant documents on the area of study were also consulted. The other source of the secondary data is provided from the primary data, the work with the base line data allows different formula to be formulated as a departure from the nature of the data to be generated in the field, since similar data from a particular field work could have yielded the same nature and unit in the parameter measured, which then allow an academic reference into the formula model generated, as a material that can be consulted. Lastly another source of secondary data is the data generated from an author who cited another author in his article.

3.3.2 Procedure of how the Data Were Refined

The summary of the procedure used to obtain the data and results include the following:

Field data were collected, the data were feed into the computer system, these feed in data were plotted using Auto cad software (Excel), Data Table were formed for the data base, generated data were use to formulate more data formula/ model relationships, the total of each variable were computed with their average mean data, standard deviation, percentage change and coefficient of variation using the excel software to allow a great precision and to enable us handling the mass data generated . the total value, mean, standard deviation were used as a pixel generator in the excel tool to generate data for r- relation and standard normal distribution z-relation, z_{cal}-relation was used to compute the z_{table} to validate the Hypothesis at 0.05 and 0.025 proportionate percentage levels 1-$z_{table,}$ 0.5-$z_{table}$and the proportionate percentage was used for decision inferment of what rate was to be dredged from the raw data generated, thus 50% of decision on all the model measurement in the study sites was suggested using cohen standard of standard error of mitigating the error that was introduced into the channel river flow.

a) Limitation of Field Data

Generally, the basic limitation of any research data acquisition may be ascribed to time, spatial constraints and resource. This is true for the fact that all researches are conducted within two years' time frame, six catchments as its spatial limitation and material facility use are expensive like the GPS Garmin 78x.and the current meter used to measure velocity stream flow.

Here, these limitations affect the work in the following ways suggested below:

i. The one year acquisition period of the data was very short, yet this dissertation work required the most basic primary data for the computation of the secondary data that was required for the analysis of the data.
ii. The economic constrain in the procurement of GPS, Current meter and the canoe ship that was used in the site navigation as a platform for Bathymetric survey exert some influence on the efficiency of navigation during the work, thus the GPS and current meter were borrowed and the canoe was hired over a period of time .
iii. The "sampling frame" that was not a true representation of the whole river channel from shiroro through Wuya reach to Muregi – Lokoja. However the temporal character of the dry season and rainy season was meant to have fair representation on the time effect over the dissertation work, again the spatial character was fairly represented by the six different site with peculiar and distinct feature that represent the whole of the river channel .
iv. The different catchment that was used in the work serve as a replica model to the whole river channel from shiroro to Lokoja river flow which dredging could be necessary over a long spatial and temporal construction work.
v. The securing of the current meter used to measure the velocity of stream flow was a problem in the first year of this research hence the department has only one that cannot be released; thus a final search for the instrument was finally secured at federal polythenic Bida Niger state, Nigeria

3.3.3 Prefield Investigation

3.3.4 Reconnaisance Survey

Before the commencement of the work in detailed field, familiarization visits were carried out to the field to be acquainted with the area. These areas were identified with distinctive landmarks that need to be studied such areas are: Evugi, Emiyamiworozhi, Wuya Kpata, Wuya kede, Dogbe and Kpayi; in other words site AB,BC, CD, DE,EF and FA which can show a relatively peculiar variation that can depicts how the channel area needs dredging more than another channel site, it allow each sites to be highlighted for the boundary to the areas that are prone and liable to flooding in the raining season, while the sand mass

generated in the dry season are equally marked and noted .All the material necessarily for the field work are collected and are make to stand by in the advent of its need in the field survey.

a) **Sampling**

Measurements of morphological and fluvial indices at six different points within the reach were carried out as coded site AB, site BC, site CD, site DE, site EF and site FA as total of FA and this catchment were measured in the following order: each at the sites respectively. the selection of each catchment follows the pattern of the settlement on each range distance; for six months starting with the highest rainfall peak at August-October and period of dry season from December to February, giving a total sampling of 6 sites x 6 periods summing to 36 samples, that is 6 periods X_1,X_2,X_3,X_4,X_5,X_6 by Y_1,Y_2,Y_3,Y_4,Y_5,Y_6 6 sites . This is illustrated in plates 1 and 2 for 3months rainy measurement on Wuya kpata site 3 while plates 3 and 4 illustrate 3monthsdry season measurement at Emiyamiworozhi site 2, Measurements taken were later averaged in the final estimated. Other site measurements were done in that pattern for sites1, sites4, sites5 and sites 6.

Plate 1: The large volume of water depicted by submerged tree plant at Wuya Kpata Site 3, During Raining Season while using Garmin GPS

Plate 2: The large volume of water in Emiyamiworozhi Site 2, During Raining Season to exploration working reach.

Plate 3: The shrinking river volume and measuring of discharge/velocity using current meter in Wuya Kpata Site3, During Dry Season

Plate 4: Showing the shrinking volume of water depicted by unsubmerged tree plant in the Emiyamiworozhi Site 2 During Dry Season at working exploration at the reach

Field study were carried out using different equipment necessary for data collected, which include Garmin 76csx Hand held GPS for recording specific coordinate of each site separately. Horizontal distances and the elevation of the sites. The data was fed into computer and plotted using AutoCAD excel software. Compass was also used to measure direction of flow, Ranging pole established origin points of survey and the alignment of distances. Others include leveling staff, a measuring tape, gage staff for establishing specific positions, and Current meter for measuring the velocity a stream flow.

3.3.4 Field Survey

(a) Measurement of Channel Morphometric Variables

Morphometric parameters suggest the estimation of space, form, slope and linear estimation among other parameters, in the following highlight:

1) Reach length=Distance of river channel site
2) Reach Breadth= Cross river distance
3) Reach area = length x Breadth
4) Reach shape=length x Breadth x elevation
5) Reach perimeter=Length +Breadth+ Depth
6) Reach slope= Elevation /Distance
7) Main channel length =Reach area x Depth
8) Canoe Density i.e. the volume of water displace by ship= Average length / Area
9) Reach elevation =measurement by GPS
10) Mean annual sediment yield i.e. sediment accumulation Fournier (1960 cited by Huggett 2011p87),

Although it has taken long but it is relevant and basic component of the fluvial study :

 - tan)

i.e. E= $e^{a.b}$ tone /km^2/year

Where E (suspended sediment yield t / km^2 /year)

And $e^{a.b}$ exponential values of a, b.

P small letter is the mean annual rainfall mm

P capital letter (precipitation of the month with the highest rainfall mm)

H (mean height/elevation of the drainage reach m)

And S (the tangent of the mean slope of the reach.)

Where 2.65, 0.46 and -1.56 are constant values for correction factor in the model. While Milliman and Mead (1983cited by Huggett 2011p87) suggested a universal Sediment accumulation

(b) Determination of Geomorphological Variables in the Reach

Fluvial Process was triggered by rainfall, erosion process, which leads to sedimentation process thus sedimentation estimation suggests among other parameters/ characteristics:

1) Channel morphology =Length x Breadth x Depth
2) Channel depth=Downward measurement
3) Bankful width=measurement from bank to bank procedure
4) Flood prone width =measurement from the bank into the settlement liable to flooding
5) Entrenchment ratio = flood prone width/ bankful width
6) Bankful mean depth by using calibrated staff
7) Water surface slope by using GPS
8) Dominant substrate in the sand

The procedure of how to use the current meter to measured the stream flow discharge was elucidated by Jaya (2008).the relation used to compute stream velocity was expantiated in the USGS(2014) and personal interviews on reasons for canoe accident, where the limit of area prone to flood exist, reasons for sudden disappearance of drowned people and the cost of flood impact on damages to life, road rehabilitation ; properties such as animals destruction, mud building collapse among other issues in the reach .

(c) Average Estimation of Morphometric Variable

The estimation of values measured in the reach was averaged to allow for measure of dispersion from the value measurement to be established and its maximum and minimum coefficient of variation to be computed. These estimation will further illustrate how the sample value varies either due to error in measurement or otherwise from real the population measurement of world/Africa denudation standard value.

(d) Estimation of River Depth/ Sediment to Removed

Table 3.1: Depth of Sediment to be Dredged per Site

Site/ BD (m)	Rainy	Dry	50% Rainy	50% Dry
Site a	2.96	1.48	4.44	2.07
Site b	2.62	1.31	3.93	1.43
Site c	4.50	2.25	6.75	3.3
Site d	3.14	1.57	4.71	2.48
Site e	3.01	1.51	4.52	4.23
Site f	4.01	2.01	6.02	2.94

River depth and Sediment to be removed are essential to dredging work in the reach site at specific particular location which serves as a guide to engineering dredging work

3.3.5 Post Field Survey

The need for dredging serves as an ecological solution to flood in the reach, this dredging can take place as real continuous channel and parches of Island dredging on the river channel, which can be estimated through scientific probing into the river flow system.

(a) Sources of estimating sand dredging in the reach

Sediment budget takes into consideration of sediment source and sinks within a system. This sediment can come from any sources and sinks consisting of:

i. Rivers
ii. Lagoons
iii. Eroding land sources
iv. Artificiel sources e.g. Management nourishment
v. Artificial sinks e.g. Mining / extraction
vi. Offshore transport
vii. Deposition of sediment on shore

(b)Different types of dredging estimate in the reach

James et.al. (2007) noted that anthropogenic activities (work of kind) reduce sediments to the coast by altering the process which supplies sediment to the coast. The activities sand and gravel mining in rivers and stream flowing to the coast, dam and flood control works navigation and

shore protection works and structural shoreline management strategies. This explanation of sand been removed and deposited immediately to the coast without transferring to another site for other uses, other than the protection of coast brim empowerment that would not allow Bankful erosion.

Another type of estimation measurement is the removal of the sand after the estimated depth of the site (shallow and deep region), only for the external uses such as the raw material for cement industry, road construction and building construction, these compares the environment coast brim empowerment and complete removal of the sand that can suggest which option is to be adopted in the advent of project development initiation. The estimated dredged sand is it to be transfer inland or not?

(c) Different techniques in sand dredging estimate in the reach

Three type of techniques can be evident: the estimate of where in the site, which of the site and how much should be estimated for each site, needs more dredging than another site, this include

i. Open dredging

ii. Modern machine dredging

iii Automatic dispersal dredging

In the open system, the estimation of how much sand must be removed for a sustainable balance ecosystem that cant trigger another effect to the environment such as opening the vent for probable petroleum oil oozing in the region and the high rate of water turbidity not been taken care; while in the modern dredging estimation of what is supposed to be dredged, how the different sites are estimated and how much is needed to be dredged.

In the Automatic dispersal machine only sediment dispersal is possible not the sand dispersal, hence it can only be dredged, which signifies how the use of estimation is compromised, thus the estimation base is strictly adhere to by the modern dredging machine hence the environmental validation.

(d) Effects of sand dredging estimate in the reach

IDAC (2006), also observed that dredging affects the channel through the following:

i. Water quality, e. g. increase of suspended solid concentration and potential realize of contaminant from the disposal sites,

ii. Habitats and natural areas e.g. .habitats enhancement or creation, removal or destruction of benthos, smothering ;
iii. Local communities e.g. the effect of noise, increased labor opportunities;
iv. Change in the bathymetry or topography;
v. Physical process e.g. waves current or drainage and hence erosion or deposition
vi. Archeological asset e.g. ship wreaks;
vii. Recreation e.g. sailing, swimming and beech use ;
viii. Economic activities e.g. commercial fishing, improved infrastructure.

The effects of estimate in the dredging survey include the following: topographical measurement about the water surface slope, the removal of sand /sediment from the habitat, the local community impact to opportunities for the development projects, the physical process including the erosion activities and deposition of the sand in the channel and the economic activities about improved infrastructure and fishing activities.

(e) Importance of sand dredging estimate in the reach

IADC (2006) identified that the importance of sand dredging are:

i. Creates under water foundation
ii. Facilitate the emplacement of pipelines or immersed tunnel elements
iii. Construct flood control structures such as dams,, dikes or leaves
iv. Ensure flood defense (by improving or maintaining the discharge capacity of water courses)
v. Create or maintain the storage capacity in the reservoirs The construction of flood control structure such as dam, dikes and leaves allow the assessment of the importance in the estimate need of data baseline and ensuring flood defense through the periodic maintenance of water courses against the blockage of sand/sediment accumulation.

(f) Problem of Sand Dredging Estimate in the Reach

Short falls in the dredging estimate for the different site spots during the field measurement may lead to erroneous sand dredging record data that could be used by the engineers in the civil engineering dredging work, hence only shallow places may necessarily needs desiltation work. Another problem in not using the baseline data generated in the field may trigger probable oil

oozing mining spot in the dredging work, which will lead to the environmental pollution within the river channel especially to the animal and plant life in the ecosystem.

(g) Casual Interview with Indegenous Settler

(i) Benefits

1) Will the dredging project calls for other investments in the area (like recreational (hotel) project, large cargoes transportation, road Construction Company using the excavated sand sediment and other social and economic activities.)?

(ii) Problems

1) Where are the limits of areas prone to flooding?
2) Is there any canoe mishap due to erosion deposition by torrential rainfall?
3) What is responsible for sudden disappearance of the drowned people to sand sediment?
4) Spirit presence, an indigenous explanation for people disappearance is it an illusion or not?
5) Is the flood occurrence due to non-channel dredging of sand sediment deposition?
6) Why is Regatta festival i.e. people showing off by paddling canoe and fish competition are in extinction?
7) Why are the large ships avoiding the river channel?
8) Why River Kaduna is called lavun (turbid) around Wuya reach?
9) Why is the wreckage of an accident vehicle around 1997 over fifteen years ago was abandon in the Wuya Kpata site not dredged?
10) Will the wreckage not cause continues environmental issue hence, oil oozing from this vehicle?

(iii) Mitigation (Reducing the problems)

For every environment that support and allow man to interact with it has its benefit and under lying problems, however the benefit from this environment is always defined been positive, while its problem is defined negative, thus the correction of these problem translating to positive can be suggested by the following mitigations questions:

i. Can the dredging need in this area stop the flooding in the rainy period?

ii. Can the dredging regulate the sudden disappearance of the drowned people due to sediment accumulation in the dry period?

iii. Can the excavation of the accident motor wreckage that falls from the overhead bridge into the site CD stop the environmental water pollution?

iv. Can the dredging reduces the canoe mishap (accident) both in the rainy and dry period either due to river dead tree (logs) or sand accumulation respectively? Thus, the characteristic that shows less cohesion in the morphometric characteristics and the drainage Characteristics in the channel flow suggests the intensity of dredging need, in another word, issues that arises in the in the channel signifies did not exist as unity (high cohesion) .

Therefore, when mitigation questions are addressed, the environmental issues of less animal that will live within the vicinity of the river, more quality fish and free tree log in each site will assist good canoe transport.

(h) Statistical Data Analysis

The post field was about data analysis included mathematical and statistical calculation which include Z test as the sample size is large, well above 30 sample, for the six sites surveyed during the three month dry / three months rainy season, Yusuf et al (2010) noted that correlation studies also investigate the likelihood of a relationship between two variables but are interested in association than cause and effect .

The statistical test explain how principal component and part analysis is used as a technique for looking at the relationship involving one set of variable that has been defined prior to the analysis and another set of variables generated from the first set of data, so that we can relate the measured data over a sample of population observed and it allows us to look into the interrelationship among these data in these way, every variables can both be independent and dependent variables at the same time .

It involve the inductive process of sampling from large order in a very large data set to allow for realistic selected data by collapsing large set of data generated ;however these technique relates the drainage /channel to the geomorphological character of the variables in the same period of measurements, also the correlation matrix was employed, the correlation structure depict strength among interrelationship of characteristics separately for the rainy period measurement and the dry period measurement.

Although, the statistical manipulation finding mean, Range, standard deviation, variance and coefficient of variation, percentage change, testing of Hypothesis, testing of significant figure among others. The use of excel packages to handle the large data of 120 values that was generated during the correlation between the 16 variables, pixel for different relation shall be employed to help programmed the data for data transformation from Pearson product moment correlation r value to z values since we are manipulating with the sample size that is above >30 samples, in our case the sample rises to 36 samples ; and the z table for normal standard distribution transformation can be used to extrapolate measure of quantitative estimation (measure of usability) in our assessment of the parameters measured in the reach mathematical calculation was undertaken using formula such as, soil loss equation or sediment accumulation equation among other characteristics of related variables in the river flow and universal discharge table of African.

(i) Calculation of Sediment Deposited in the Reach

Huggett (2011) suggested a formula relationship for sediment yield with almost three constant values accounting for their correction factor, Fournier (1960cited by Huggett 2011p87) uses sediment data from78 drainage basin correlated suspended sediment yield with a climatic parameter according to the available data thus making the equation a standard and universal fluvial formula, although it is long, but its relevance among researchers is unique.

 -tan) this universal equation that relates the climatic condition of rainfall in the stream flow with its relief morphology. However he did not consider other factor such as physical denudation process

(ii) Pearson Product Moment Correlation Coefficient r

Pearson product moment correlation coefficient (r) from the below:

□□−□□□□□□□□,□=sdn for data above thirty up ward >30, where n=120

Z_{cal} The Excel formula is unique in the computation of all the components formula starting each computation with a = sign.

Z_{table} Excel package formula that can be used to compute the Standard normal distribution Table (=NORMS DIST).

(iii) Pixel Data Generator

Table 3.2 The total value pixel X or Y

PARAMETERS	TOTAL (x or y)
(SA)	1743.217
CD	0.011417
RE	473.24
RA	3522300
RL	8296
RP	10333.85
RS	0.08
RD	2020.4
MCS	0.026485
(RLS)	1.352
CM	10652700
CD	15.6025
FPW	662.89
ER	1.95
SD	-0.77821
SV	0.81796

SOURCE: Field Work at Wuya Reach on River Kaduna (2013)

or)

PARAMETERS	MEAN
(SA)	348.6434
CD	0.002283
RE	94.648
RA	704460
RL	1659.2
RP	2066.77
RS	0.016
RD	404.08
MCS	0.004414
(RLS)	0.225333
CM	1775450
CD	2.600417
FPW	110.4817
ER	0.325
SD	-1.11
SV	0.0393

SOURCE: Field Work at Wuya Reach on River Kaduna (2013)

Table 3.4: The standard deviation value pixel S

PARAMETERS	STANDARD DEVIATION
(SA)	0.1283
CD	0.001314
RE	23.31466
RA	790944.1
RL	1481.979
RP	1514.366
ES	1.17E-02
RD	1.04E+02
MCS	2.25E-03
(RLS)	4.95E-02
CM	2.12E+06
CD	6.89E-01
FPW	8.52E+01
ER	0.152676
SD	0.42117
SV	0.33503

SOURCE: field work at Wuya Reach on River Kaduna (2013)

Table 3.5 The x- x̄ or y -ȳ difference value pixel

PARAMETERS	x- x̄ or y -ȳ
(SA)	1394.674
CD	0.009134
RE	378.592
RA	2817840
RL	6636.8
RP	8267.08
RS	6.40E-02
RD	1616.32
MCS	2.21E-02
(RLS)	1.13E+00
CM	8.88E+06
CD	1.30E+01
FPW	5.52E+02
ER	1.63E+00
SD	0.332
SV	0.7877

SOURCE: field work at Wuya Reach on River Kaduna (2013)

(iv) Standard Normal Distribution (z)

Appendix VI and VII, depicts the transformation of the raw data Z_{cal} to Z_{table} relation of normal standard distribution table, thus the positive transformed values are to the right, while the negative transformed values are to the left; the probability that the standard normal distribution lies between the two can be justified by both + values and- value as it can be evident from the z-values below in the Appendix. In other word the transformed z-value can be categorized into two distinct pattern +VALUES AND – VALUES explaining values tending toward the center (0) from the right and the values tending toward left to the center (0)

Again, With reference to Appendix VI, that depicts the interrelationship between the characteristics of the stream channel, it explain the Z value, which needs another Appendix for the further Transformation of the z value to z Table which is explained in its Appendix VII in their normal order; it is only one out of 120 inter relation BD/SA that depicts <0.5from the z_{table} which has a proportionate percentage of <50%higher than the starting measurement or the initial measurement, while the rest depicts- 0.5 to +0.5which indicate 50% higher rate than the initial

measurements of all parameters. Again the detailed computation could be found in the Appendix IV

However, the 50% measurement was inevitable for DE siltation work that can allow for a dynamic measurement to be enhanced in the river channel throughout, without a negative Environmental impact to Wuya Reach

Appendix VI and VII, depicts the transformation of the raw data Z_{cal} to Z_{table} relation of normal standard distribution table, thus the positive transformed values are to the right, while the negative transformed values are to the left; the probability that the standard normal distribution lies between the two can be justified by both + values and- value as it can be evident from the z-values below in the Appendix. In other word the transformed z-value can be categorized into two distinct pattern +VALUES AND – VALUES explaining values tending toward the center(0) from the right and the values tending toward left to the center (0).

(v) Use Of 50% Proportionate Decision For Sediment Removal

50% measurement was inevitable for DE siltation work that can allow for a dynamic measurement to be enhanced in the river channel throughout, without a negative Environmental impact to Wuya Reach

However, it is only one out of 120 inter relation BD/SD that depicts <0.5 from the z_{table} which has a proportionate percentage of <50%higher than the starting measurement or the initial measurement, while the rest depicts- 0.5 to +0.5which indicate 50% higher rate than the initial measurements of all parameters. Again the detailed computation could be found in the Appendix IV.

(vi) Statistical Advantage of Excel and Excel Data Limitation

(a) Advantage Of Using Of Excel For Data Computation

(i) It reduces error in the computation of large and many values

(ii) If one solution is derived, others can be inferred

(b) Limitation In The Use Of Excel For Data computation

i. It cannot assess power of value e.g. $2.2x10^2$ instead 220 or 2.2E+2
ii. When copying excel formula, the empty space disobey the copying continuity

iii. Asterisk "** 0.995" is recognized for multiplication, slash "–"for division, capital letter "E" for exponent and for mean "average"
iv. Every formula must begin with = before starting any computation
v. Serious work is enhanced in order to construct the four pixels
vi. Raw data enter into computation for a total pixel of 120 value, mean pixel of 120 values, deviation pixel of 120 values and difference pixel of 120 value

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION

The result of determination of parameters/ characteristics with their subscript are presented to indicate the Drainage reach/channel characteristics such as sediment accumulation (SA), Accumulation density (AD), Reach area (RA), Reach length (RL), Reach perimeter (RP), Reach shape (RS), Bankful distance (BD) and Reach elevation (RE) while the geomorphological characteristics includes:

Main channel slope (MCS), Reach length slope(RLS), Channel morphology (CM), channel depth (CD), Flood prone width (FPW), Entrenchment ratio (ER), stream discharge (SD) and stream velocity (SV).Also the rainfall data during the rainy season and the non-rainy period are Compared, these produced the summary components of the model formula adopted.

4.2 STREAMFLOW RESULTSPRESENTATION IN WUYA REACH

This chapter involves the presentation of results and their explanation which consist of some subdivision to allow for more elucidation into each division and this include the explanation of the Drainage reach/channel

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