THE EFFECTS OF POOR DRAINAGE SYSTEM ON ROAD PAVEMENT: A REVIEW

TIZA, MICHAEL TORYILA - M. Tech Scholar (Transportation engineering) Career Point University, India.
Email - tizamichael@gmail.com
IORVER, VITALIS TERPASE - B.Engg (civil engineering) University of Agriculture, Nigeria.
Email - terpasevitalis@ymail.com
IORTYOM, ENOCH TERLUMUN - Ph.D. Research Student, Department of Geography and Environmental Sciences, University of Fort Hare, Alice Campus, Eastern Cape Province, South Africa.
Email - iortyomenoch@gmail.com

Abstract: This study is carried out to review various research works carried out by researchers on the effects of poor drainage on road pavement. Poor drainage causes early pavement distresses leading to driving problems and structural failures of road as pointed out by researchers. To prevent or minimize premature pavement failures and to enhance the road performance, it is imperative to provide adequate drainage. The review covered: importance of highway drainage system in road construction, requirements of highway drainage system, and effects of bad drainage system on roads. The research pointed out areas of concern for drainage designers and road engineers that are of great importance during road construction to ensure that, the constructed road is put to use without failure before the actual design life. The review concluded that effect of poor drainage condition on a road is very adverse. It causes the failure of road in different ways and as well economic hardship on inhabitants of affected communities with devastating effect of sicknesses as a result of breeding of mosquito especially on streets in towns with poor drainage capacity. Proper drainage system provided to the road increases the life of roads. But the improper drainage system causes the failure of the road at its early edge. Therefore effective engineering practices should be considered necessary during design, construction and management of roads and drainage channels.
Key Words: Poor, Drainage, Road, Pavement, Construction, Accident, Highway, Geometry.

INTRODUCTION:

Highway pavement is carried out to make travelling convenient. Road construction requires the creation of an engineered continuous right-of-way or roadbed, overcoming geographic obstacles that will make the foundation stable and having grades low enough to permit vehicle or foot travel and may be required to meet standards set by law or official guidelines. After pavement, Storm drainage is designed to drain excess rain and ground water from impervious surfaces of the road to fix defects and preserve the pavement's structure and serviceability.

After road pavement, erosion and sediment controls are constructed to prevent detrimental effects. Drainage lines are laid with sealed joints in the road easement with runoff coefficients and characteristics adequate for the land zoning and storm water system. Drainage systems must be capable of carrying the ultimate design flow from the upstream catchment with approval for the outfall from the appropriate authority to a watercourse, creek, river or the sea for drainage discharge

Drainage quality is an important parameter which affects the highway pavement performance. The excessive water content in the pavement base, sub-base, and sub-grade soils can cause early distress and lead to a structural or functional failure of pavement. Drainage is the most important aspect of road design. Proper design of drainage is necessary for the satisfactory and prolonged performance of the pavement. In designing drainage, the primary objective is to properly accommodate water flow along and across the road and conveniently transport and deposit the water o the downstream without any obstruction in the flow.

A typical road construction is multi-layered in form, comprising of unbound materials. Essentially, the lower indigenous subgrade layer is covered by a bound or unbound sub base, providing drainage and frost protection for the subgrade , and the road base layer upon which the asphalt layers are laid as a

final surface coating. Poor drainage in pavement can lead to early pavement distresses lead to driving problems and structural failures of the road.

The primary source of water in pavements is atmospheric precipitation. This water can enter the pavement through several ways (e.g., cracks, infiltration, through shoulders and ditches, high groundwater) and is moved by an energy gradient, such as gravity, capillary forces, osmotic forces, and temperature or pressure differences. The drainage designer is primarily concerned with saturated gravity flow, which can be determined by application of Darcy's law.

To understand and analyse the conditions under which the pavement must function, the designer needs information on highway geometrics, surface drainage, non-paved subsurface drainage, climate, and soil properties. These data enable the designer to predict the amount of free water that will enter the pavement structure, to predict the free water surface, and to establish the design subgrade moisture content.

AIM OF THE REVIEW:

This research work is specifically carried out to review literature on the effects of a poor drainage system on road pavement. The review will broadly be determined to review on the:

i. importance of highway drainage system in road construction works,
ii. requirements of highway drainage system,
iii. Effects of a bad drainage system on roads.

LITERATURE REVIEW ON ROAD DRAINAGE SYSTEM:

Highway Drainage System

Highway drainage is the process of removing and controlling excess surface and sub-surface water within the right way. This includes interception and diversion of water from the road surface and sub-grade. The installation of suitable surface and sub-surface drainage system is an essential part of highway design and construction. Highway drainage is used to clear surface water from the highway. Good highway drainage is important for road safety. Roads need to be well drained to stop flooding; even surface water can cause problems with ice in the winter. Water left standing on roads can also cause maintenance problems, as it can soften the ground under a road making the road surface break up and as well lead to an accident from the road users (Amit, 2016).

Dipnoan, (2014) studied highway surface drainage system and problems of water logging and concluded that adverse roadway elements contributing to highway accidents were substandard roadway alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement centre and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route, haphazard bus shelters/stops, and others are causes of water logging problem in highway. This research traced that Proper drainage is a very important consideration in design of a highway. Inadequate drainage facilities can lead to premature deterioration of the highway and the development of adverse safety conditions such as hydroplaning. It is common, therefore, for a sizable portion of highway construction budgets to be devoted to drainage facilities.

Muhammad, (2014) studied highway drainage system and started that highway is importance for removing water from the road surface, preventing ingress of water into the pavement, passing water across the road, either under or over and preventing scour and/ or washout of the pavement, shoulder, batter slopes, water courses and drainage structures. He identified types of drainage on the highway to include kerb and gullies, surface water channel, combined filter drain (French drain), over-the-edge drainage, drainage channel locks, combined kerb and drainage units, linear drainage channels, fin and narrow filter drain (sub-surface drainage) and edge drainage for porous asphalt.

According to civil engineering dictionary (2014), highway drainage includes collecting, transporting, and disposing of surface/subsurface water originating on or near the highway right of way or flowing in

streams crossing bordering that right of way. This is important because of water damage highway structure in many ways. The water which are dangerous for highways are: Rainwater: Cause erosion on surface or may seep downward and damage pavement (surface drains), Groundwater: May rise by capillary action and damage pavement (sub-surface damage) and water body: May cross a road (river/stream) and may damage road (cross drainage words).

In a research on drainage on roads by Singh, Navpreet and Nitin (2014), a well-designed and well maintained road drainage is important in order to: minimize the environmental impact of road runoff on the receiving water environment, ensure the speedy removal of surface water to enhance safety and minimize disruption to road users and to maximize the longevity of the road surface and associated infrastructures. Water in the pavement system can lead to moisture damage, modulus reduction and loss of strength. In order to prevent such damages to the pavement, it is essential to provide proper drainage to the roads. They maintained that the presence of water in a highway layer reduces the bearing capacity of the road, and in doing so it also reduces the structure's lifetime. Highway drainage is used to clear surface water from the highway. Roads need to be well drained to stop flooding; even surface water can cause problems with ice in the winter. Water left standing on roads can also cause maintenance problems, as it can soften the ground under a road making the road surface break up.

Requirements of Highway Drainage System:

Ger Finn, et al (2004) designed the guidelines for road drainage which stressed that drainage is a basic consideration in the establishment of road geometry and in general this means that the drainage should meet the following: cross falls should be a minimum of 2.5% on carriageways, with increased cross falls of up to 5.0% on hard shoulders draining to filter drains; longitudinal gradients should not be less than 0.5% on kerbed roads; flat areas should be avoided and consideration of surface water drainage is particularly important at rollovers, roundabouts, and junctions; outfall levels must be achievable; the spacing of road gullies should be sufficient to remove surface water whilst achieving an acceptable width of channel flow. One gully for every 200sq. m of paved surface is generally found to be satisfactory.

According to Bath & North East Somerset Council (2016), Highway drainage should fulfil the following objectives: prevent flooding, ponding and seepage, and keep the carriageway, cycleway and footway as free of standing water as possible; ensure surface water falling on the highway enters the drainage system or natural watercourse as speedily as possible; keep the underlying road structure as dry as possible; prevent injury or damage caused by hazardous surface water; prevent highway surface water flooding adjacent properties and prevent blockages in associated highway drainage systems with consequential flooding.

The council maintained that highway drainage requires routine maintenance to ensure its continued efficiency. From time to time, additional maintenance is essential to ensure the system continues to function properly. Gullies and their immediate pipe connection are emptied and cleaned as part of an annual proactive maintenance programme. Drainage is cleaned as followed: rural areas - once per year, urban areas- once per year, and high-speed dual carriageways twice per year. However, where persistent problems are identified with gully cleansing, for example, being blocked by silt and detritus on a regular basis, the gullies are specifically identified and programmed for a greater cleaning frequency.

According to NCHRP (1998), a drainable pavement contains the integral components as shown in Figure 1 below. The primary components include the asphalt or concrete surface pavement, a permeable base, a separator/filter layer, the subgrade, and edge drains Table 1 shows the optional elements that can be selected for the design of each component. If any of these system components do not function properly, the system will not perform (e.g., a drainable pavement that does not drain will be a liability to the pavement system).

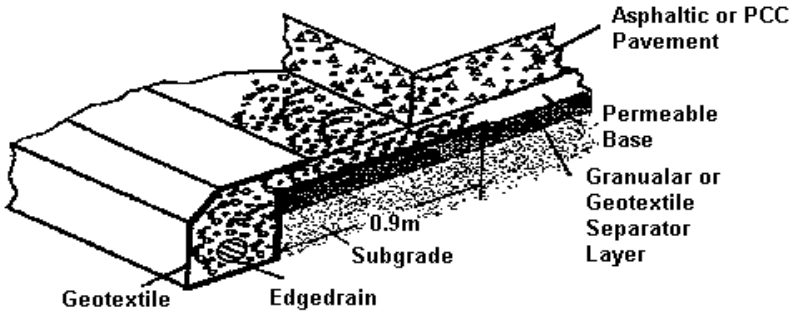

Fig. 1: Components of a pavement drainage system.
Source: NCHRP (1998).

Table 1: Components of a Pavement Drainage System

Basic Components	Variable Components
Surface Pavement	Rigid: Portland Cement Concrete Flexible: Asphaltic Concrete
Permeable Base	Unstabilized Granular Asphalt Stabilized Granular Cement Stabilized Granular
Separator/Filter Layer	Dense-Graded Granular (Sub base) Geotextile
Subgrade	Strength of Subgrade Soil Location of Water Table Final Grade
Edge drains (including outlets with headwalls)	Aggregate Trench Drain w/ Geotextile Filter & Pipe Prefabricated Geocomposite Edge drain (PGED)

Source: NCHRP (1998).

Effects of Bad Drainage System on Roads

Bad drainage has damage and loss in serviceability of both rigid and flexible types of pavements much greater when structural section contains free water. The Quality of drainage is an important parameter which affects the performance of the highway pavement. Poor drainage quality on roads leads to a large amount of costly repairs or replacements long before reaching their design life. The gradation and properties of layer materials seldom permit the layer to be an effective drainage layer, leading to entrapment of water within the pavement causing a "bathtub" condition, resulting in premature failures and chronic pavement distresses. Many research works have been carried out on the effect of a poor drainage system on roads as it will reviewed below.

Jitendra et al (2013) carried out a framework for quantification of the effect of drainage quality on structural and functional performance of pavement by identifying a simple framework for quantification of the effect of drainage quality on structural as well as functional performance of the pavement. They presented the structural and functional performance of the pavement in predicted terms of deflection and roughness respectively. Their study was useful to reduce the maintenance cost of highway pavement system and to preserve huge highway network in India.

Getachew et al (2015) based their research on the assessment of the effect of urban road surface drainage: A case study at Ginjo Guduru Kebele of Jimma town. They: assessed the pavement damage due to improper drainage, identified areas most prone to flooding problems, assessed the existing condition of road and surface drainage infrastructure, examine the impacts of road surface drainage structures integration on road performance and related social as well as environment issues and make recommendations on urban road and drainage structures integration, their provision and management. They conducted a cross-sectional study in Ginjo Guduru Kebele of Jimma town from January to August 2014.The data they collected was then analyzed quantitatively and qualitatively, and

the results from their study were presented in tables and in themes. From the study made, generally, they observed that the road surface drainage found to be inadequate due to insufficient road profile, insufficient drainage structures provision, improper maintenance and lack of proper interconnections between the road and drainage infrastructures thereby resulting to the damages to road surface material and flooding in the area.

Victor, (2010). Carried out an investigation into the adequacy of the drainage system on Narok-Mai Mahiu road which was determined to: examine the adequacy of the drainage system in Narok-Mai Mahiu road, study the effects of inadequate drainage systems on roads and the surrounding environment, and to investigate the reasons for inadequate drainage systems in Narok-Maai Mahiu road and the challenges faced by the institutions mandated with the responsibility of maintaining them. They employed a research survey in order to obtain the information that would describe the state of drainage infrastructure in Narok Maai Mahiu road and how poor drainage affected the surrounding environment and the road users. Various data collection techniques that were used include questionnaires, photographs, observation, and interviews. The results indicated that Narok Maai Mahiu road drainage system was not adequate to satisfactorily drain the runoffs. As a result, the surrounding environment was greatly affected as exemplified by runoffs washing away some sections of the road and bridges, creating gullies on peoples' land, blockage of the road, loss of life and property and washing away of the fertility of the land. Poor design, workmanship,and maintenance were the main challenges. He then pushed that drainage facilities should be improved through maintenance, gabions be built for remedying of gullies and construction of water conservation structures e.g. water pans to hold and reduce the speed of water. Furthermore, redesign of the whole drainage system in Narok-Mai Mahiu road should be considered.

Siddhartha et al (2012) carried out a research on drainage and flexible pavement performance; in the research, they pointed out that providing adequate drainage to a pavement system has been considered as an important design consideration to prevent premature failures due to water related problems such as pumping action, loss of support, and rutting, among others. They continued that most water in pavements is due to rainfall infiltration into unsaturated pavement layers, through joints, cracks, shoulder edges, and various other defects, especially in older deteriorated pavements. Water also seep upward from a high groundwater table due to capillary suction or vapour movements, or it may flow laterally from the pavement edges and side ditches. Providing adequate drainage to a pavement system has been considered as an important design consideration to ensure satisfactory performance of the pavement, particularly from the perspective of life cycle cost and serviceability. To minimize premature pavement distresses and to enhance the pavement performance, it is imperative to provide adequate drainage to allow infiltrated water to drain out from the base and sub-base, thus avoiding saturation of base and subgrade soils.

Magdi, (2014) studied the impacts of poor drainage on road performance in Khartoum, a city in Sudan with two case studies; attempts were made to find out the reasons for road failure within the first five years as a result of poor drainage. In this quest, it was discovered that four basic reasons lead to early deterioration of road pavements in the study, these factors according to the research includes, Poor drainage design and construction, poor maintenance structure, use of low-quality materials and no local standard of practice .It was concluded that if these factors are put into consideration in planning and execution and if improved on pavement structures would serve within its expected design life.

Patil and Jalinder (2011) studied the effects of bad drainage on roads with precision on some roads in India. It was found that increase in moisture content increases the chances of road failure before the stipulated or expected design life. It was observed that on Service road to Mumbai Pune Expressway the blockage of drainage channels lead to accumulation of water on pavement thus, leading to the stripping of bitumen. On walhekarwadichowk road, poor drainage leads to formation of waves and corrugations which as well leads to increase in weight and thus increases the stress causing the simultaneous reduction in strength of soil mass. On Nehru Nagar Road, Pimpri Akurdi Railway Station Road, and Holkar Bridge Chowk, Khadaki it was found that water penetrated into the subgrade thus making it weak and subsequently development of potholes as a result of water logging. The Approach road to

railway tunnel near Akurdi Railway Station was observed to be bad condition due to flood in rainy seasons.

Getachew and Tamene (2015) made a study on Assessment of the Effect of Urban Road Surface Drainage using GinjoGuduruKebele of Jimma Town in Ethiopia as a case study. It was found that road surface drainage of the study area was found to be inadequate due insufficient road profile, insufficient drainage structures provision, improper maintenance and lack of proper interconnection between the road and drainage infrastructures thereby resulting damages to road surfacing material and flooding problems in the area.

Magdi, (2016) investigated surface drainage problem of roads in Khartoum state, Sudan. A comprehensive study was done using appropriate land and traffic survey equipment. Several roads were surveyed which lead to conclusions as; The drainage problem is highly compounded in Khartoum state because of inadequate drainage system thereby resulting in damages of pavements and leading to unhealthy environment, poor drainage conditions especially during rainy seasons, force the water to enter the pavement from the sides as well as from the top surface. The most common causes of road drainage problem were found related to improper road geometry, insufficient capacity of drainage structures, poor construction, and lack of proper maintenance. It was recommended that Proper road geometry needs to be maintained to provide required crown and longitudinal slopes, Provision of proper connections or integrations between the road network and drainage network systems ~~is~~ are required with regular maintenance, deficiencies in road drainage should be identified and ranked in order of priority as part of the normal maintenance program, Road authorities should consider providing a specific budget on an annual basis for both drainage maintenance works, drainage improvement works , A program for cleaning out the surface drainage system is essential. Developing the skills of using software programs for planning, analysis, and design, maintenance of road surface drainage system in urban areas and monitoring the drainage infrastructures.
Owuama et al (2014) studied Sustainable Drainage System for Road Networking, the research was aimed at suggesting an alternative and sustainable drainage system which is a trenchless drain comprising absorption unit and grass cover. It was found that the technology would provide a cheap, aesthetic and effective method of disposing road surface runoff with minimal distress to users and minimal damage to the environment. It was concluded that trenchless drains dispose accumulated surface water easily and introduces aesthetics to the environs, and an antidote to mosquito breeding which consequently reduces the incidence of malaria.

To determine whether a drainage system is adequate or not, Jitendra et al (2013) presented a table of AASHTO classification of drainage system as shown in table 2 below.

Table 2: AASHTO Relationship between layer's drain ability and subjective drainage quality rating

S. No	Drainage Quality (DQ)	Water Removed From Layer Within
1	Excellent	2 hour
2	Good	1 day
3	Fair	7 days
4	Poor	1 month
5	Very Poor	Water will not drain

Source: Jitendra et al (2013).

Agbonkhese et al (2013) studied bad drainage and its effects on road pavement conditions in Nigeria and came up with some reasons as to why there is poor or bad road conditions relating to drainage. Their research stressed that: Poor maintenance, poorly executed construction jobs, negative attitude of residents and noncompliance to existing master plan of town has been the cause of poor road conditions. They concluded that poor drainage has led to a fast deterioration of most roads in Nigeria and government and respective bodies should also take into consideration, proper design, and maintenance culture to enable the constructed roads to be put to use to meet their designed life.

Dipanjan, (2014) did a study on a road stretch in India and came up with the following reasons contributing tremendously to water logging and subsequently fast road deterioration substandard roadway alignment or geometry, lack of shoulders and shoulder defects, absent or inappropriate pedestrian facilities, narrow and defective lanes and bridges/bridge approaches, roadside hazards, undefined pavement centre and edge lines, poor sight distances and visibility, unmarked and inappropriate design of intersections, serious allocation deficiencies along the route, haphazard bus shelter/stops, and others are causes of water logging problem in highway.

Rokade, et al (2012) carried out research on drainage related performance of flexible highway pavements in which they started that the drainage design criteria used in the past for drainage design have been based on the assumption that both the flow of water through pavements and the drainage of pavement layers can be represented with saturated flow assumptions. They concluded that effects of water can be reduced by preventing water from entering the pavement, providing adequate drainage to remove infiltration, or building the pavement strong enough to resist the combined effect of load and water. Pavement service life can be increased by 50% if infiltrated water can be drained without delay. Similarly, pavement systems incorporating good drainage can be expected to have a design life of two to three times that of un-drained pavement sections.

Need for the Study:

Due to incessant fast failure of pavements years before their design life, especially the flexible pavement with poor drainage capacity as the one of the main causes of both functional and structural failure, it became necessary to undertake this research in order to bring out the effects of the poor drainage in various ways.

CONCLUSION:

From the review, it has been concluded that poor drainage facilities on highway structures has many devastating effects on the economy of users, as both functional and structural failures due to poor drainage leads to increase in travel time, thus reducing productivity of a community or nation, it leads to sicknesses such as Malaria fever due to breeding of mosquitoes in stagnant water around poorly drained pavements in residential areas, there is increased number of accidents thus leading to the death of many. etc.

The effect of poor drainage condition on road is very adverse. It causes the failure of road in different ways. Proper drainage system provided to the road increases the life of roads. But the improper drainage system causes the failure of the road at its early edge. Therefore effective road drainage should be taking into consideration during construction of roads.

Thus, proper design, construction and maintenance practices should be adopted to keep roads drained.

REFERENCES:

1. Agbonkhese Onoyan-usin, Yisa Godwin Lazhi, & Daudu Paul Itomi-ushi. (2013). Bad Drainage and Its Effects on Road Pavement Conditions in Nigeria. Civil and Environmental Research, 3(1), 7-15.
2. Amit, K. D. (2016). Drainage system in highways. Term paper in transportation engineering. Lovely professional Univerity. Puniab-India. https://www.scribd.com/doc/42527504/Drainage-System-in-Highways
3. Bath & North East Somerset Council (2016). Highways drainage. http://www.bathnes.gov.uk/services/streets-and-highway-maintenance/drains.
4. Civil engineering dictionary (2004). highway drainage. http://www.thefreedictionary.com/drainage
5. Dipanjan Mukherjee. (2014). Highway Surface Drainage System & Problems of Water Logging In Road Section. The International Journal Of Engineering And Science (IJES), 3(11), 44-51.
6. Ger, F., Donal, B. Kieran, K., John, M., Dominic, M. and Jim, P. (2004). Guidelines for road drainage. Department of the Environment, Heritage and Local Governmen. Roinn- U.S.A.
7. Getachew KebedeWarati, Tamene AdugnaDemissie. Assessment of the Effect of Urban Road Surface Drainage: A Case Study at GinjoGuduruKebele of Jimma Town. International Journal of Science, Technology and Society. Vol. 3, No. 4, 2015, pp. 164-173. doi: 10.11648/j.ijsts.20150304.20
8. Jitendra, G., Pradeep, K. A. and Manoj, K. S. (2013). A Framework for quantification of effect of drainage quality on structural and functional performance of pavement. International Journal of Engineering Research. Volume No.2, Issue No. 3, pp : 257-263
9. Magdi, M. E. Z. (2014). The Impacts of Poor Drainage on Road Performance in Khartoum. International Journal of Multidisciplinary and Scientific Emerging Research, 3(1). Retrieved from

https://www.researchgate.net/publication/267630089_The_Impacts_of_Poor_Drainage_on_Road_Performance_in_Khartoum
10. Magdi M. E. Zumrawi. (2016). INVESTIGATING SURFACE DRAINAGE PROBLEM OF ROADS IN KHARTOUM STATE. International Journal of Civil Engineering and Technology (IJCIET),7(3) 91-103.
11. Muhammad, B. B. (2014). Highway drainage system. https://www.linkedin.com/pulse/20141125045254-112545392-highway-drainage-system
12. National Cooperative Highway Research Program (1998).Pavement Subsurface Drainage Systems. Road Management & Engineering Journal. http://www.usroads.com/journals/rmej/9803/rm980304.htm
13. Owuama C. O, Uja E, & Kingsley C. O. (2014). Sustainable Drainage System for Road Networking. International Journal of Innovation, Management and Technology, 5(2), 83-86.
14. PatilAbhijit, &PatilJalindar. (2011). Effects of Bad Drainage on Roads. Civil and Environmental Research, 1(1), 1-7.
15. Victor K. Rono. (2010). An Investigation into The Adequacy Of The Drainage System On Narok Mai Mahiu Road (Bachlor's thesis, University Of Nairobi, Kenya). Retrieved From http://realestates.uonbi.ac.ke/sites/default/files/cae/artsdesign/realestates/Final%20project.pdf
16. Rokade S, Agarwal P.K, &Shrivastava R. (2012). STUDY ON DRAINAGE RELATED PERFORMANCE OF FLEXIBLE HIGHWAY PAVEMENTS. International Journal of Advanced Engineering Technology, 3(1), 334-337.
17. Siddhartha, R., Agarwal, P. K and Rajnish, S. (2012). Drainage and flexible pavement performance. International Journal of Engineering Science and Technology. Vol. 4 No.04 pp. 1308 – 1311
18. Singh, R. R., Navpreet, K. and Er.Nitin, G. (2014). Drainage on roads. International Journal of Progresses in Civil Engineering. Vol. 1(1). Pp. 2394 – 4684
19. Tiza,Michael. Control of Flooding at Banks of Rivers Case Study of River Benue Bordering University of Agriculture Makurdi Water Works , International Journal of Engineering Science and Computing, April 2016. P 4047-4089.
20. Abata Stephen, Tiza Michael, Iorwua Bem, & Olu Sunday. (2016). A REVIEW OF SOIL ERODIBILITY Case Study of UGBOJU Settlement of OTURKPO Local Government Area of Benue State Nigeria. EPRA International Journal of Multidisciplinary Research (IJMR), 2(6), 95-99.

BIOGRAPHY

TIZA Michael Toryila obtained B.Engr. (Civil Engineering) from Federal University of Agriculture Makurdi Nigeria and is currently pursuing a masters in Transportation Engineering and an MBA (Construction Management) in India. He has published many articles in accredited and recognised journals of national and international repute. He is a member of many professional bodies such as; American Society of civil Engineers (ASCE), Nigerian Society of Engineers (NSE), Universal Association of Civil, Structural and Environmental Engineers (UACSE), International Association of Engineers (IAENG), Institute of Transportation Engineering (ITE) etc.

IORVER,**Vitalis Terpase** obtained a Bachelor of Civil Engineering from the prestigious Federal University of Agriculture Makurdi Nigeria. He is currently working as a design Engineer with a construction Company in Nigeria. He has published many articles in accredited and recognised journals of national and international repute.

IORTYOM, Enoch Terlumun is a Ph.D. Research Student from Department of Geography and Environmental Sciences, University of Fort Hare, Alice Campus,Eastern Cape Province, South Africa. He earned both B.Sc.Hons. and M.Sc. degrees in Geography from Benue State University, Makurdi, Nigeria. He has published in accredited and recognised journals of national and international repute.