ROUTE RE-ALIGNMENT SURVEY FOR COST EFFECTIVE CONSTRUCTION OF A CONNECTING BRIDGE OVER SULEJA-DAM

Ibrahim, O.P., Mark, Z, Isau, A.I., Samaila-ija, H.A., Ajayi, O.G. & Nwadilor, I.J.
Department of Surveying and Geoinformatics, Federal University of Technology, Minna, Niger State, Nigeria.

Before the construction of Suleja dam in 1993, people and goods were conveyed / transported freely through the old road because the small river separating the adjoining communities (Ija, sabo bwari, ija kuchiko and ija koro) had a small bridge that accommodated vehicular and other means of transportation. However, because of the construction of the dam, the communities once connected are now separated in their economic and social interaction. In view of this; this research was carried out with the aim of realigning the old road to accommodate a shorter and cost effective bridge over the dam. Differential Global Positioning System (DGPS) receivers were used to set-out the new alignment while an Automatic level was used to transfer height from the Benchmark to the lake. Eco Map 50s was used to carry out the strip sounding over the proposed bridge route to determine the water depth. A total length of 2.919km was obtained from the proposed realignment as against a distance of 3.038km of the old alignment. As a result, a proposed bridge length of about 514m was achieved as against the 740m of the old alignment. AutoCAD 2010 and Carlson were used to plot the alignment, as well as the longitudinal profile and length calculation. In addition Layer stacking of the existing alignment and new alignment of the area on satellite imagery of the site was also carried-out in order to depict the differences between the existing road and the proposed realignment.

Keywords: *Communities, Bridge, Route Realignment ,Transportation*

piusibrahim.uk@gmail.com

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INTRODUCTION

Surveying is a complete system which involves data capture and storage on site either by direct or indirect means using instruments and techniques that are appropriate for executing the task at hand. There are several branches of surveying such as; Hydrographic Surveying, Engineering Surveying, Military Surveying, Geological Surveying etc. but this research combines Hydrographic and Route survey in order to have a design of a bridge. Route surveying is the measurement made which involves horizontal profile (along center line) and cross sections. This line contains both distance and bearing of the route. On the other hand, Hydrographic surveys are those made on a body of water such as bay, dam, harbor, lake or river. Hydrographic surveys are made for the purposes of determining channel depths for navigation, quantities of bottom excavation, location of rocks, sand bars, navigation aids, measurement of area subject to scour or silting, for offshore structure sitting and bridge construction amidst others (Raymond et al, 1981). Therefore *Bathymetric surveying* is the process of measuring the depth of water to obtain the topography of the bottom. All over the world roadways have had to be re-aligned for various reasons, ranging from traffic safety issues, major public infrastructural development, economic and cost considerations, growing population and city or metropolis growth, buffer from risk or potentially dangerous areas. Of all these factors mentioned above, man's aim still remains to effectively convey goods, services and people from one place safely to another.

Rutland (2006), presented a detail report on his research which executed a route re-alignment between Cornish road and portions of Rutland road, old Vernon road. A newly constructed three-lane arterial roadway was used to tie an existing three-lane road between old Vernon and Rains road. However the Right of Way (ROW) was constructed to permit a four-lane roadway in case of future traffic. The existing Rutland road became a cul-de-sac south of old Vernon road. This provided further traffic allowance at the vicinity of highway Vernon road by removing closely spaced intersections. DGPS was used for carrying out the realignment survey.

However, whatever the need be for re-alignment, administrative considerations must be made. Feasibility study of such an area is carried-out in other to determine whether a road can be situated in such areas or not. Preliminary investigation such as subsoil investigation, vegetation and terrain, need for culvert and bridges are all carried-out. Maps and topographic relief charts of such areas are used for office reconnaissance to effectively determine where the alignment should pass through.

Transportation in every society is of major importance, as there is a need for movement of goods, services and people from one destination to another. Roads are one of major means by which such can be done. Roads have been constructed over time and can be traced to the creation of man, as man saw a necessity to travel from one point to another and in doing this he has come across obstacles such as water bodies, valleys etc. Man has over the years constructed bridges over such obstacles. In this light the communities of Ija, Tofa, which are separated by a dam; and because of the frequency of transportation and movement of goods by boats and ferries, need the construction of a bridge over this dam for more effective transportation. Route re-alignment is necessary for the construction of a new bridge over Suleja dam to connect the communities of Ija and Tofa, and also serving Kaduna, Bwari, etc. A map would be produced showing the profile of the road, to aid in proper design and

planning of the road and bridge, as well as to show a suitable route that would save the cost of a bridge construction.

Bridges are part of road construction because the topographic of the earth is undulated, large water bodies sometimes separate towns and hence the need for a bridge to connect the towns.

However a bridge must be built when factors such as frequency of usage, volume of transported materials or goods, size of town's apart and economic as well as social factors are taken in to consideration. All over the world, bridges have been constructed but however routes with less cost implications have been used. It is necessary in every construction exercise to follow routes with the most minimal cost implication on the government. Therefore the proposed realignment for the construction of a bridge over Suleja dam will not only reduce the length of the bridge, but would also cut cost; most importantly for the Federal Government and also help connect communities such as Ija, Tofa, Bwari, the FCT as well as link the ongoing road project passing through Bwari into Kafanchan, and also link Plateau State.

Route Realignment Using GIS

Planning a new road or highway can be expensive and time consuming process. There are numerous environmental issues that need to be addressed. The problem is exacerbated where the alignment is influenced by the location of services, existing roads and buildings, and the financial, social and political costs of land resumption.

GIS, a powerful tool for the compilation, management and display data associated with geographic space, is used for the preparation of digital maps and analysis purposes. The conventional manual methods were difficult, time consuming and expensive. (Subramani e tal, 2012). The purpose of this study was to develop a tool to locate a suitable less route between two points. The GIS approach using ground parameters and spatial analysis provided to achieve this goal. Raster based map analysis provide a wealth of capabilities for incorporating terrain information surrounding linear infrastructure .Costs resulting from terrain, geomorphology, land use, drainage and elevation resulting the shortest routes for the study area. The existing road path was 90 km long from Erode to Palani (via Kangeyam, Dharapuram). Results indicate that the route which was designed applying GIS method is more environmentally effective and cheaper. This proposed shortest route provides traffic free, pollution free, risk free, operating for movement of vehicle passing from Erode to Palani. Time and consumption of fuel will also be reduced considerably. (Subramani & Kumar, 2012)

Study Area

Suleja dam is located between two communities in Tafa Local Government Area of Niger State. Latitude $09^0$14' 37'' and Longitude $07^0$17'15''. The Suleja dam over which the proposed bridge is to pass across was built in 1994, by the then Head of State Ibrahim Badamose Babangida as a Federal Government intervention program in Niger state, to help check water scarcity and shortage of clean and portable water for general consumption. The dam holds 36×10^6 cubic meters of water according to its initial design over an area of about

460 Hectares. Suleja dam is located in an area full of rocks of varying types, ranging from igneous, metamorphic and also sedimentary rocks. The dam is a zoned Earth filled water reservoir, constructed by dredging the sloppy side of the mountains. The area also has a good relief and a beautiful landscape towards its banks that support agriculture and grazing of cattle. However the hilly side of the dam is characterized by gully erosion, as water and other materials moving with high velocity during rainfall from the mountains, easily erode the Earth. This has made foot paths in the area difficult to navigate by motorist and motorcyclist.

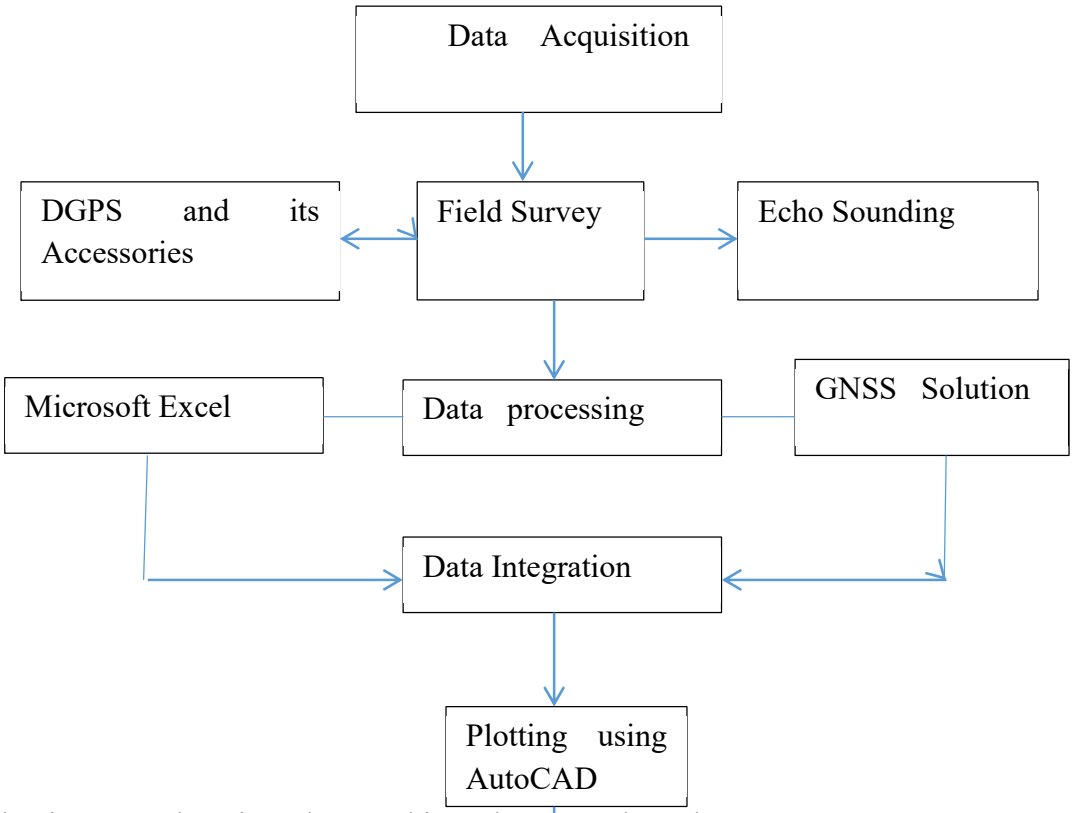
Climatic Conditions of the Area

Available geographic information indicates that the quantity of rainfall in the study area ranges from 50.2mm to 260.5mm during the month March to May when peak rainfall is recorded. The month of November to March and April are the hottest month of the year with temperatures ranging from 33^0c to 39^0c in April. The lowest temperature of 19^0 occurs in the month of December, while relative low temperature of 27^0c to 32^0c occurs during others months of the year. It is during these months of relatively low temperatures that evaporation values of 66 to 112 are recorded. The highest evaporation values of 220 to 245ml are recorded during December to April due to the high temperatures and low, rainfall prevailing during this period. It was further observed that the highest value of relative humidity (67% - 72%,) occurs between June and August while the lowest valves (14% to 22%) occur between December and march**.**

Materials and Method

This research employs the use of Differential Global Positioning System (Pro mark 3, Dual Frequency) receivers, Eco Sounder, handheld GPS, 100m steel tape, leveling instrument, a boat and all its accessories, Microsoft excel, and AutoCAD software packages. The method involves collecting 3 dimensional coordinates (X, Y, and Z) of observed selected points using direct field survey with the aid of DGPS receivers and its accessories. The DGPS base were set up on a control point (FCT 222p) and all necessary instrument set up and testing was carried out to ascertained the accuracy of the instrument (instrument calibration) i.e. bar check, after setting up. To densify the controls, the instrument was set up on static method of observation (for control extension). The occupation time spent on one control point to establish it was one hour fifteen minutes (1hr: 15m) and for the route alignment (edges and center line), the instrument was set on stop and go method of observation where 15-20 seconds was spent on each point at a chainage of 25 meters and the center line was six meters apart. Echo sounder was used to determine the depths at 10 seconds interval. Level instrument was used to reduce the water level for the day observation. GNSS Solution software was used to process the data and AutoCAD Land Dev. was used to process the data in order to produce profile map of the route realignment.

Fig 1: Flow Chart of Methodology



The following were done in order to achieve the research goal;

i. Determination of distances, area and angles
ii. Establishment of reference s ertical controls.
iii. Determination of profile on l is to pass(centerlines) to provide data for cuts and
iv. Utility placements, as well as laying of structures, culverts and bridges
v. Depth determination of dam to enable bridge construction and support system.

Discussion of Results and Findings

Controls are established / reestablished in survey job in order to orient the job at hand or subsequent one where the existing controls have been destroyed or damaged and in some cases where they are far from the intending area of survey. The controls established in the course of this research were four with beacon numbers IJ02 to IJ05. The distance covered from IJ02 to IJ03 was 486.317m, IJ03 to IJ04 was 1092.33m and from IJ04 to IJ05 was 410.811m respectively.

Table 1.0: Second order controls established along the route

Pillar Number	Eastings(m)	Northings(m)	Height(m)
IJ05	306321.332	1021951.87	478.931
IJ04	306728.924	1022003.193	469.016
IJ03	307670.258	1022557.339	473.392
IJ02	308149.184	1022641.804	479.74

Table 2.0 shows the route realignment observed data. The Easting's, Northings and Heights in black, are the observed points on ground while the ones in blue are the points observed on the water body (reduced depth). The lowest point in the lake (through the profile) was 444.293m, the heights point on the profile map is 487.594m, total length of the realigned road was 2.919km while the total length of the old road is 3.038km. The length covered during strip sounding (profile sounding) was 493.03m and the length of proposed new bridge was 514.063m plus excess on land. The length of proposed old bridge was 731.430m plus excess on land and the difference in length between the proposed new bridge and the old one was 217.370m plus excess on land

Table 2.0: **Coordinates from route survey and strip bathymetry survey in blue**

s/no	Eastings(m)	Northings(m)	Height(m)	s/no	Eastings(m)	Northings(m)	Height(m)
1	308380.515	1022614.574	478.599	42	307411.7	1022348	464.85
2	308354.369	1022609.471	478.946	43	307392.1	1022331	465.295
3	308331.551	1022607.126	479.049	44	307373.4	1022315	463.868
4	308305.266	1022603.031	479.343	45	307354.1	1022299	463.162
5	308279.898	1022598.513	479.675	46	307330.5	1022288	463.262
6	308257.017	1022594.985	479.847	47	307311	1022280	458.793
7	308231.526	1022591.343	480.264	48	307292	1022273	459.393
8	308205.806	1022588.828	480.459	49	307274	1022260	458.893
9	308180.348	1022584.864	480.56	50	307236	1022253	458.493
10	308155.798	1022580.698	480.532	51	307217	1022246	457.893
11	308131.726	1022574.627	480.476	52	307198	1022239	456.893
12	308107.458	1022571.614	480.472	53	307180	1022232	455.693
13	308082.512	1022566.311	480.675	54	307161	1022219	453.693
14	308056.352	1022562.659	480.69	55	307142	1022219	452.793
15	308032.994	1022558.051	480.54	56	307123	1022212	452.093
16	308008.786	1022554.915	480.405	57	307104	1022205	446.493
17	307983.028	1022552.764	480.285	58	307086	1022198	444.293
18	307958.423	1022547.219	479.998	59	307067	1022191	449.163
19	307935.36	1022544.804	479.726	60	307048	1022184	452.893
20	307907.783	1022540.129	479.038	61	307029	1022178	453.693
21	307883.725	1022535.291	478.748	62	307010	1022171	454.093
22	307858.551	1022531.734	478.26	63	306992	1022164	455.893
23	307836.248	1022527.27	477.765	64	306973	1022157	458.493
24	307811.713	1022524.903	476.836	65	306916	1022137	459.293

25	307785.475	1022520.252	476.098	66	306898	1022130	459.793
26	307763.236	1022517.25	475.418	67	306879	1022123	460.193
27	307737.011	1022513.2	474.741	68	306871.9	1022121	464.242
28	307711.85	1022511.647	473.639	69	306850.6	1022111	465.03
29	307687.469	1022508.42	473.111	70	306829.4	1022097	465.737
30	307661.313	1022505.249	472.106	71	306807.8	1022085	466.433
31	307637.009	1022500.799	471.448	72	306786.7	1022072	466.965
32	307611.718	1022496.06	470.563	73	306766.5	1022058	468.01
33	307591.054	1022483.655	469.89	74	306743.1	1022046	468.855
34	307568.669	1022470.955	469.134	75	306721	1022034	469.711
35	307546.051	1022460.43	468.228	76	306699.9	1022021	470.102
36	307526.376	1022445.447	467.598	77	306677.4	1022008	470.687
37	307508.625	1022428.108	467.223	78	306658	1021998	470.789
38	307488.652	1022413.297	467.376	79	306635.5	1021986	470.789
39	307468.379	1022396.761	466.386	80	306612.6	1021973	469.183
40	307448.796	1022381.46	466.052	81	306587.5	1021969	465.824
41	307430.011	1022364.515	465.37	82	306563	1021964	470.237

s/no	**Eastings(m)**	**Northings(m)**	**Height(m)**	**s/no**	**Eastings(m)**	**Northings(m)**	**Height(m)**
83	306537.383	1021960.017	473.073	103	306048	1021874	482.995
84	306513.828	1021953.981	474.203	104	306023.5	1021870	483.317
85	306490.418	1021948.601	474.617	105	305998.6	1021866	484.103
86	306465.074	1021945.406	475.656	106	305971.9	1021862	485.284
87	306440.015	1021940.602	476.509	107	305948.8	1021858	484.392
88	306414.886	1021936.037	477.19	108	305924	1021854	484.1
89	306391.839	1021930.614	478.093	109	305899	1021851	483.921
90	306366.376	1021926.755	478.904	110	305875.5	1021846	483.865
91	306342.551	1021920.75	479.368	111	305851.3	1021843	484.404
92	306317.768	1021914.978	477.689	112	305826	1021841	485.151
93	306291.666	1021910.642	478.467	113	305800.3	1021836	485.042
94	306271.516	1021905.596	477.183	114	305776.8	1021830	485.222
95	306246.375	1021903.747	479.509	115	305752.1	1021827	485.371
96	306216.372	1021896.944	480.081	116	305727.5	1021824	485.83
97	306196.334	1021898.636	480.238	117	305703	1021819	485.707
98	306170.289	1021893.551	480.718	118	305676.7	1021815	486.307
99	306146.148	1021886.502	484.206	119	305651.8	1021811	486.665
100	306121.048	1021882.753	484.001	120	305625.8	1021816	487.594
101	306096.309	1021879.087	482.192	102	306072	1021877	482.555

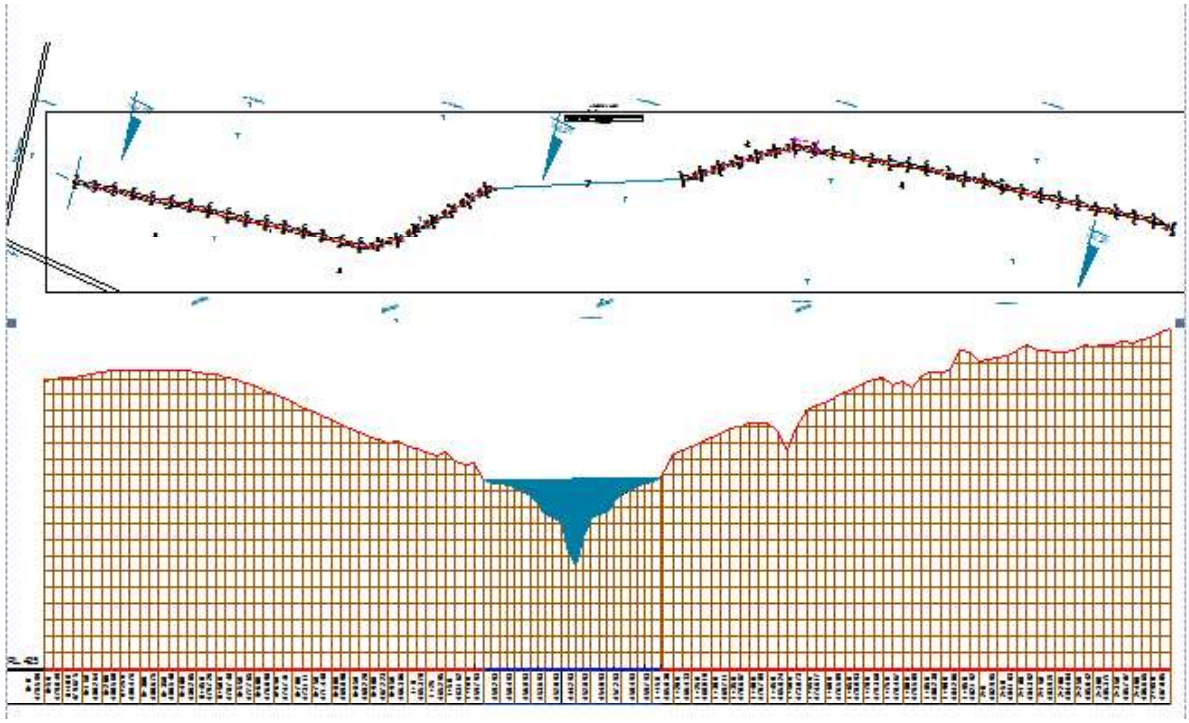


Fig.2 A profile view of the realigned road.

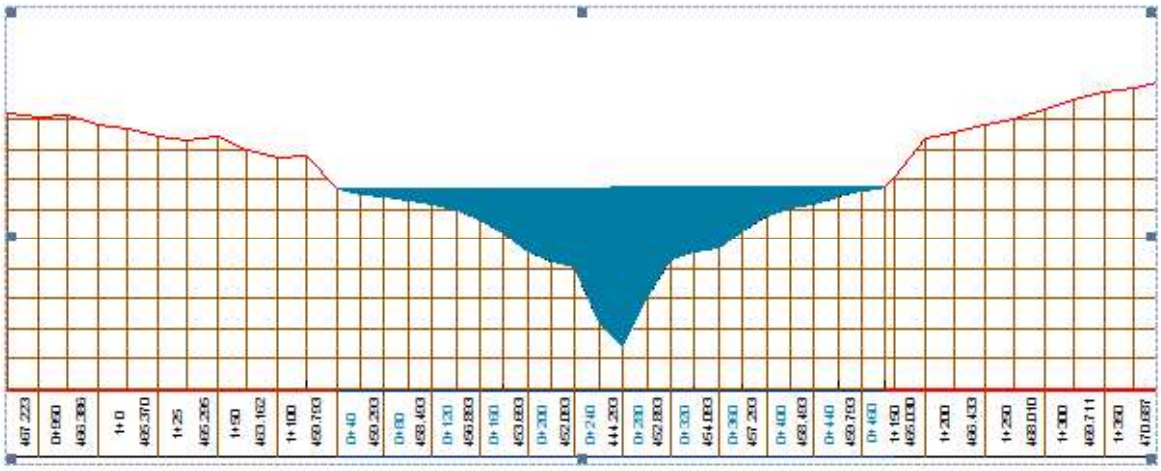


Fig 3: Profile along the Dam.

Fig4: The realigned road superimpose on the satellite imagery

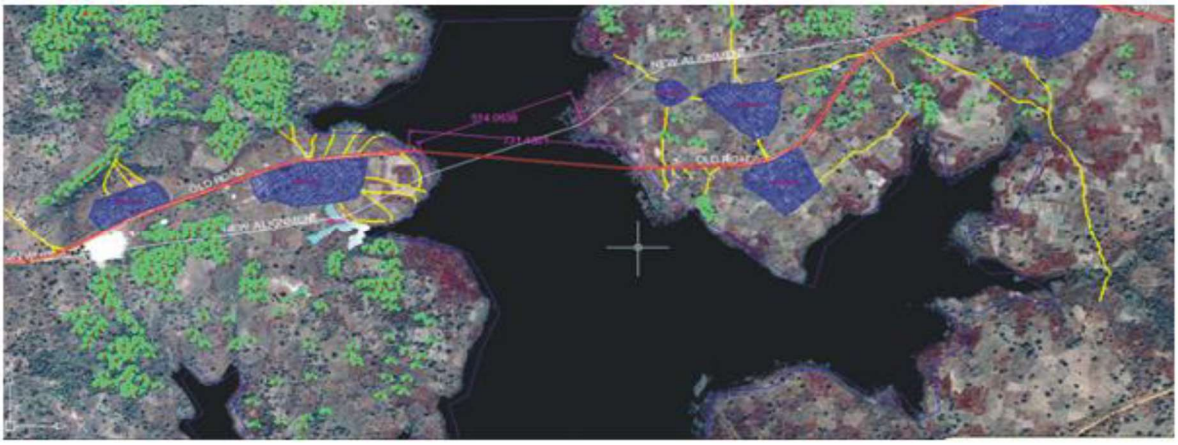


Fig5.: A plane view of the realigned road in white.

In Fig.5, the road in red shows the existing road that needs a bridge to be constructed over to link Ija, Bwari and the entire FCT, to KOFA, Sabon Wuse and Kaduna road. According to the old road design, it was observed that a bridge of about 750m or more will be required to be constructed over the dam to link the above communities. However, with the new realignment carried out, a bridge of only about 500m or more but not exceeding 525m will be required to connect the above communities. This will further save cost as the new alignment provides a shorter and less expensive route. Furthermore, the new alignment has been designed to allow free flow of traffic and to accommodate vehicular design speed, due to the fact that the new alignment is to be constructed in the out_skirt of the communities highlighted in order not to disturb activity going on in the settlement and also to reduce the cost of compensations. Since houses are being constructed close to the roadway recently. The route is an economically important road to the communities, as it helps in the transportation of goods and services, such as farm produce. Finally the major benefit of this

project to the Federal Government of Nigeria is the reduction of cost of construction; because since the old road is about 750m and above, it will cost the government more to construct the bridge. It was also discovered that the new alignment of the road will cost the government less than the initial cost of constructing the bridge, and the aim of the project would have been meant.

CONCLUSION AND RECOMMENDATION

In conclusion, it is safe to say that using the new alignment a significant length would be reduced thereby saving cost of bridge construction. The Governments of Niger state and the Federal Capital Territory should come together and join forces to make sure that this project is realized because of the economic and social benefits the project has to offer to both states. Because of the good nature of the environment, a Survey resort should be constructed there to aid the development and practice of surveying in the country. This message is targeted at NIS, NGOs and investors.

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