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# Digital Elevation Modeling Of Multipurpose Multi-Objective River Basin Project

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**ABSTRACT**
This research is aimed at developing digital elevation model of multipurpose multi objective projects with specific objectives of identify and produce aerial maps of three towns with rich river basin projects; digitize the produce aerial map, develop digital elevation and 3D model of the projects. River basin in Nigeria has being abandoned because of the problem of optimally allocating resources to multipurpose multi objective river basin projects. A hypothetical model was developed using Civil 3D, AutoCAD and ArchiCad. Digital elevation model of the hypothetical multipurpose project was developed using Arc view GIS and Suffer 14. The results showed 3D surface map of digitized hypothetical model of three communities A, B, and C with strategic multipurpose multi objective projects which includes hydroelectric power station, fish pond, irrigation canal, erosion and flood control, recreation, navigation , dam and reservoir for water supply scheme. The developed mode is useful in optimally allocation of resources to water resources river basin projects. Ministry of power, agriculture, tourism, and water resources should adopt the use of such model in implementation of river basin optimization policies sequel to the fact that it will yield optimal profit.
**KEYWORDS:** Digital elevation, 3D models, Aerial maps, Hypothetical model, Water resources,

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## I. INTRODUCTION

In this research a hypothetical simulation of multipurpose multi objective project was developed to simulate the application of hydraulic jump in river basin development and management. Hydraulic jump is the rise in water level in a flow, especially, in open channels as a result of abrupt change in flow regimes from unstable, turbulent, shooting and supercritical flow to a relatively stable, tranquil, streaming and subcritical flow (Akpan and Ledogo, 2015). It has the advantages of being use to solve some hydraulic engineering problems. It can be used to enhance irrigation water supply, mix chemicals for water purification, aerate water and waste water for water treatment and removal of air bubbles in supply lines, etc. Combining energy and momentum equations, a mathematical model to determine the engineering characteristics of a jump were derived (Ledogo 2012). The characteristics of hydraulic jump includes Froude number, length of jump, head loss, strength of jump, power dissipate, maximum length of hump, contraction width, velocity after jump and energy loss. The equations of the model was programmed in visual basic programming language and used to predict the characteristics of hydraulic jump (Akpan and Ledogo, 2015; Orton, 2012).

A hypothetical model representing three communities' surrounded by rich river basins and long world's history of cost allocation practices in multipurpose multi objective projects was developed using Archi Cad, Suffer 8 and other digital elevation model tools (Okada , 2015). The developed hydraulic jump model was simulated and used to obtained several benefits in a multipurpose multi objective projects (Ahmad, Zhang, Liu, Naveed, Zaman, Tayyab , Waseem and Umar , 2018). The hypothetical model present three communities that optimizes several multipurpose multi objective projects such as fishing, Navigation, water supply

management scheme, recreation and tourism, flood control scheme and hydroelectric power stations ((Mousavi ,Nasrin , Asl-Rousta and Kim, 2017). Bayesian and game decision theory are useful tools to solve resources allocation problems under uncertainty, optimally maximize enormous profit and minimize cost of executing the projects.

## II. MATERIALS AND METHODS

Several tools were used to develop and digitize the model which includes Visual basic 10.1, Suffer 14, Archi CAD, Civil 3D, Digitizer and Data acquisition software. The method employed includes using Geographical information system(GIS) to produce an aerial view of the three communities. Digitizer was used to digitize the photogrammetry of the towns to the system by entering spot heights of the area to produce the 3D model.

**Model's Application**

The model so far developed is applicable in river basin optimization and is very useful for optimal maximization of profit from river basin. Here is a hypothetical multipurpose project development in a river basin area. This presentation is mainly to effectively demonstrate the application of the new simulated model in river basin optimization. Below are pictorial presentations of the model using Civil 3D, AutoCAD and Archicad.

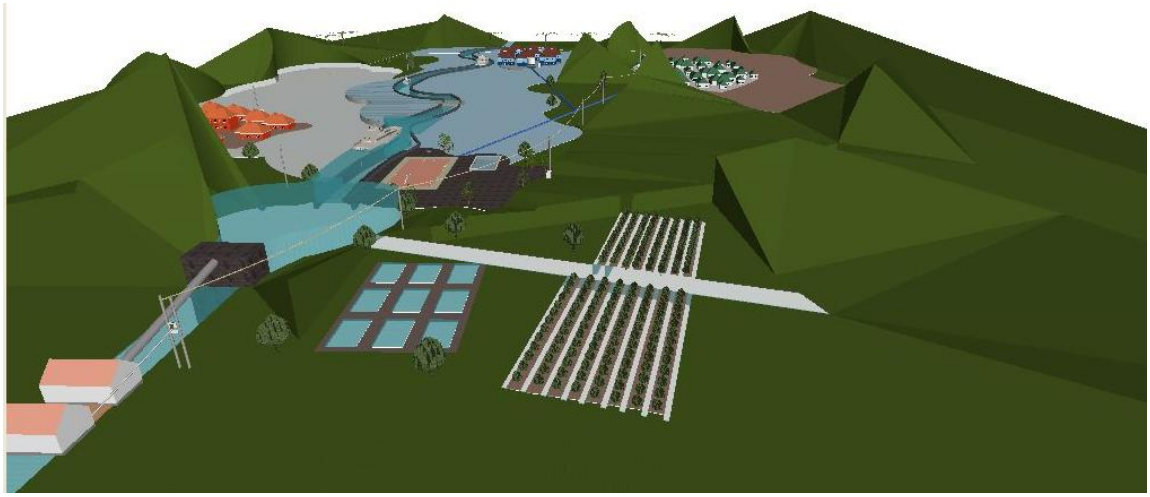

**Figure 1: Front View showing the direction of flow from upstream to down stream**

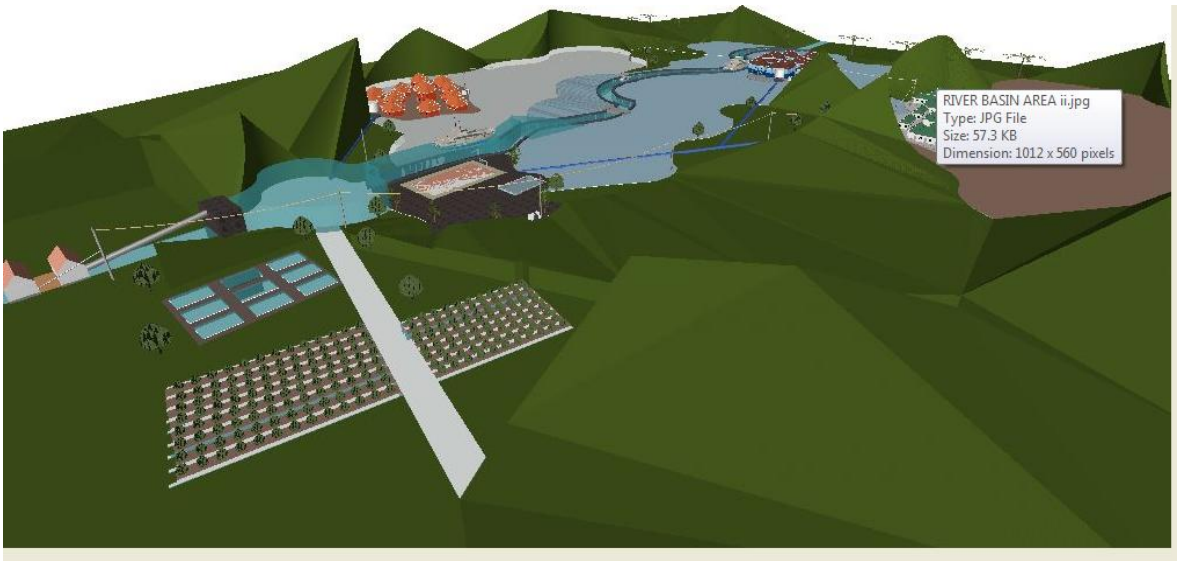


**Figure 2. Front View showing the reservoir distributing water to fish pond and irrigation farm.**

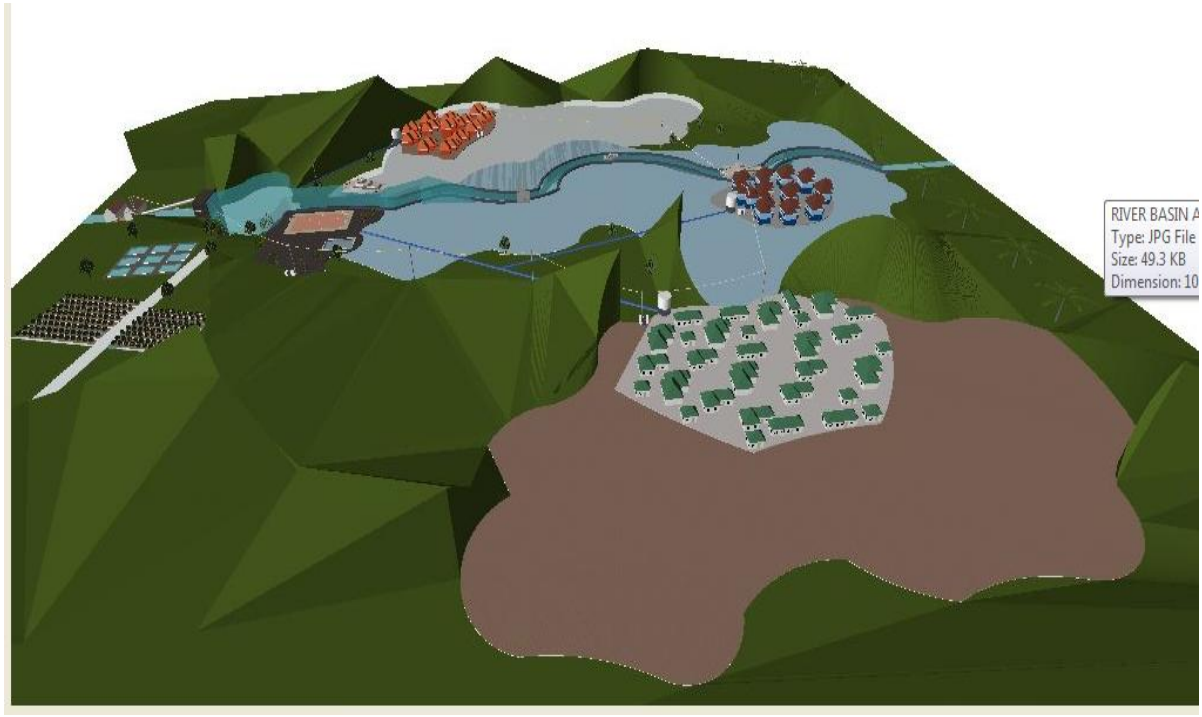


**Figure 3.Side view showing the three communities and the features entire river basin**

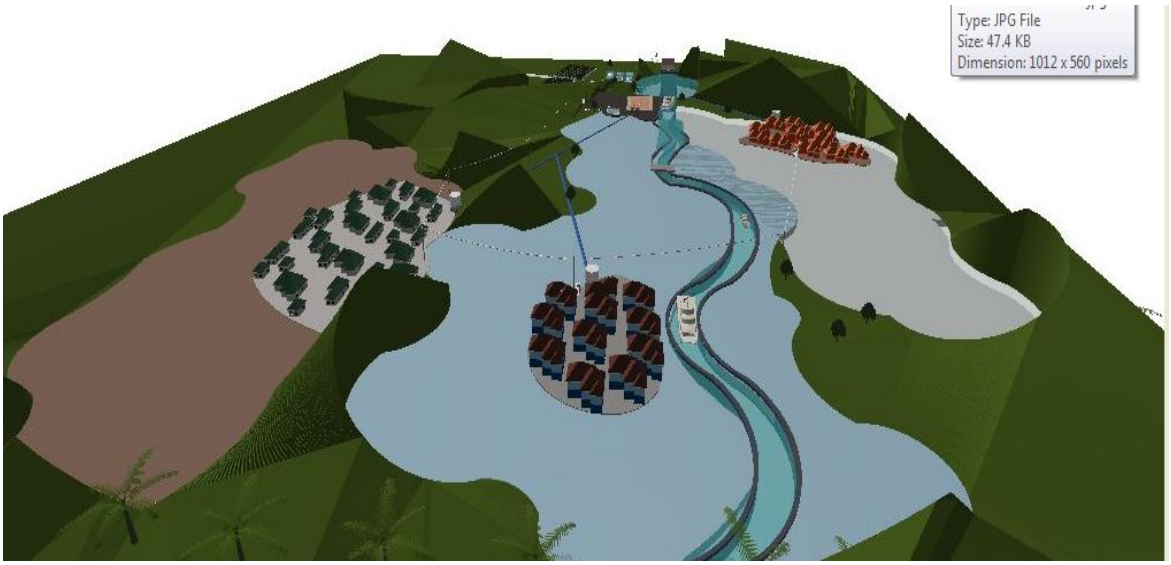


**Figure 4.Back View showing the direction of flow with ships navigating from upstream to down stream**


**Figure 5.Side view showing town C and water logged plain for drainage**

**Figure 6. Front view showing hydroelectric power generation station and power transmission lines distributing power to town A, B, and C.**

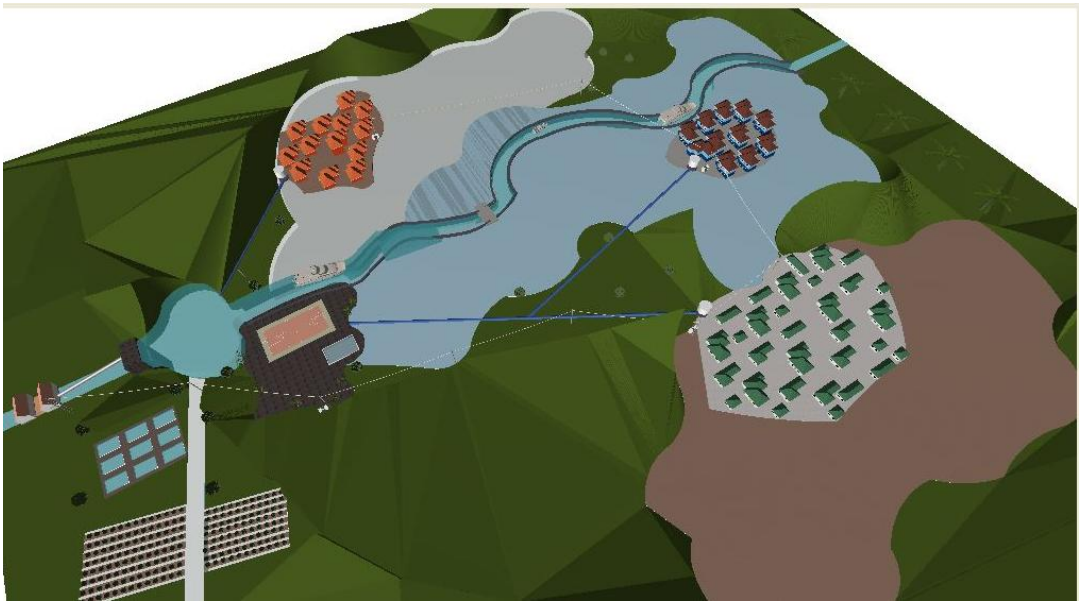

**Figure 7.Top Aerial showing town A, B and C with the River Basin.**

**Digitization of the Hypothetical Multi-Purpose Project**

Arc view GIS was further used to digitize the hypothetical multi-purpose project development in a river basin area. Below is the presentation of the digitized hypothetical model.

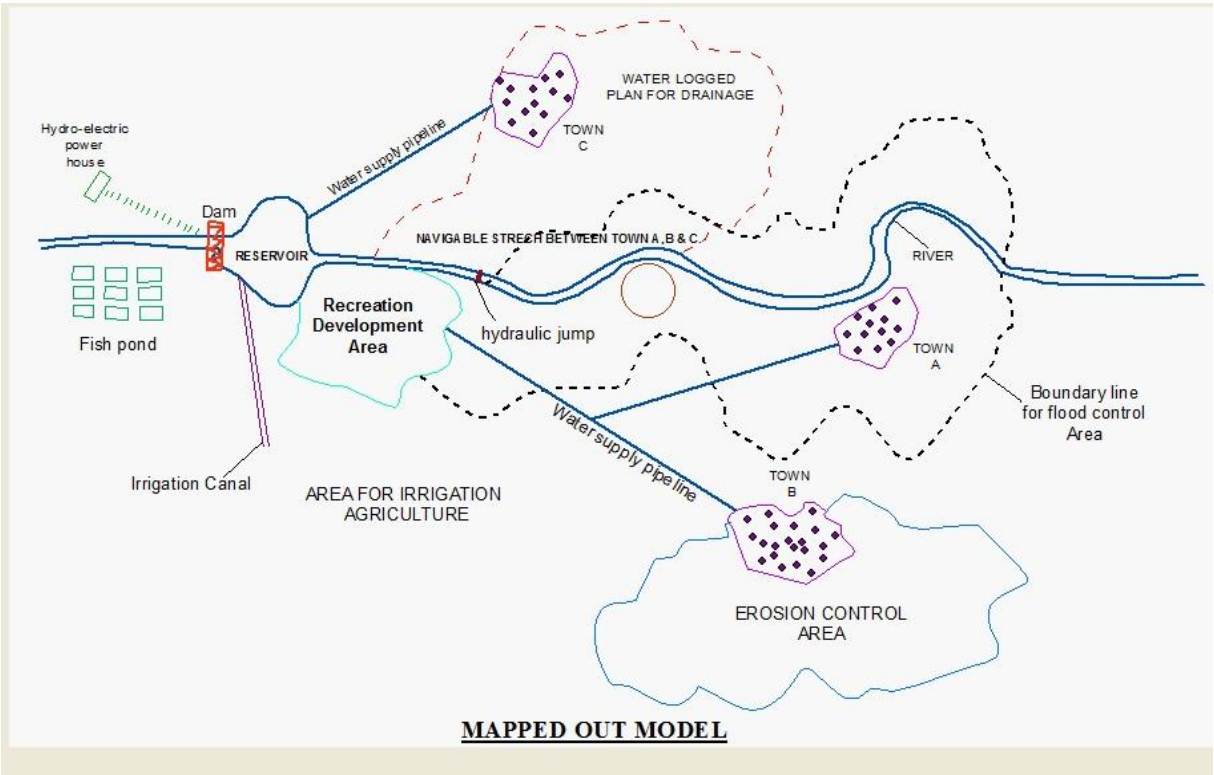


**Figure 8.Showing digitized mapped out model**

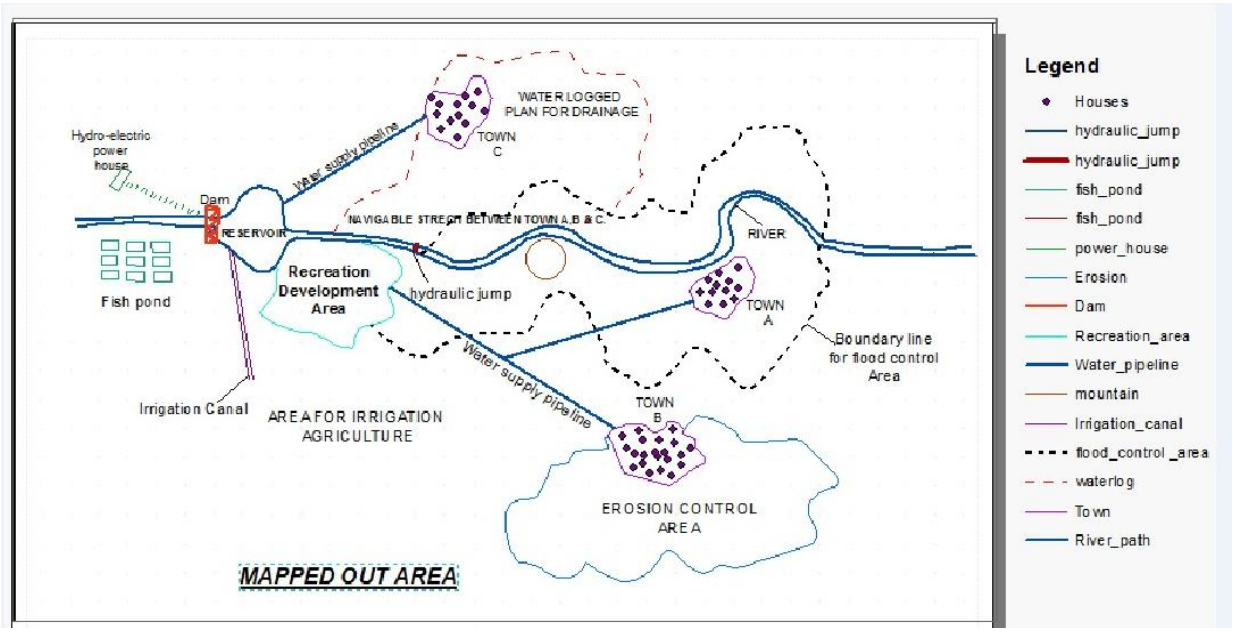


**Figure 9.Showing digitized mapped out area**

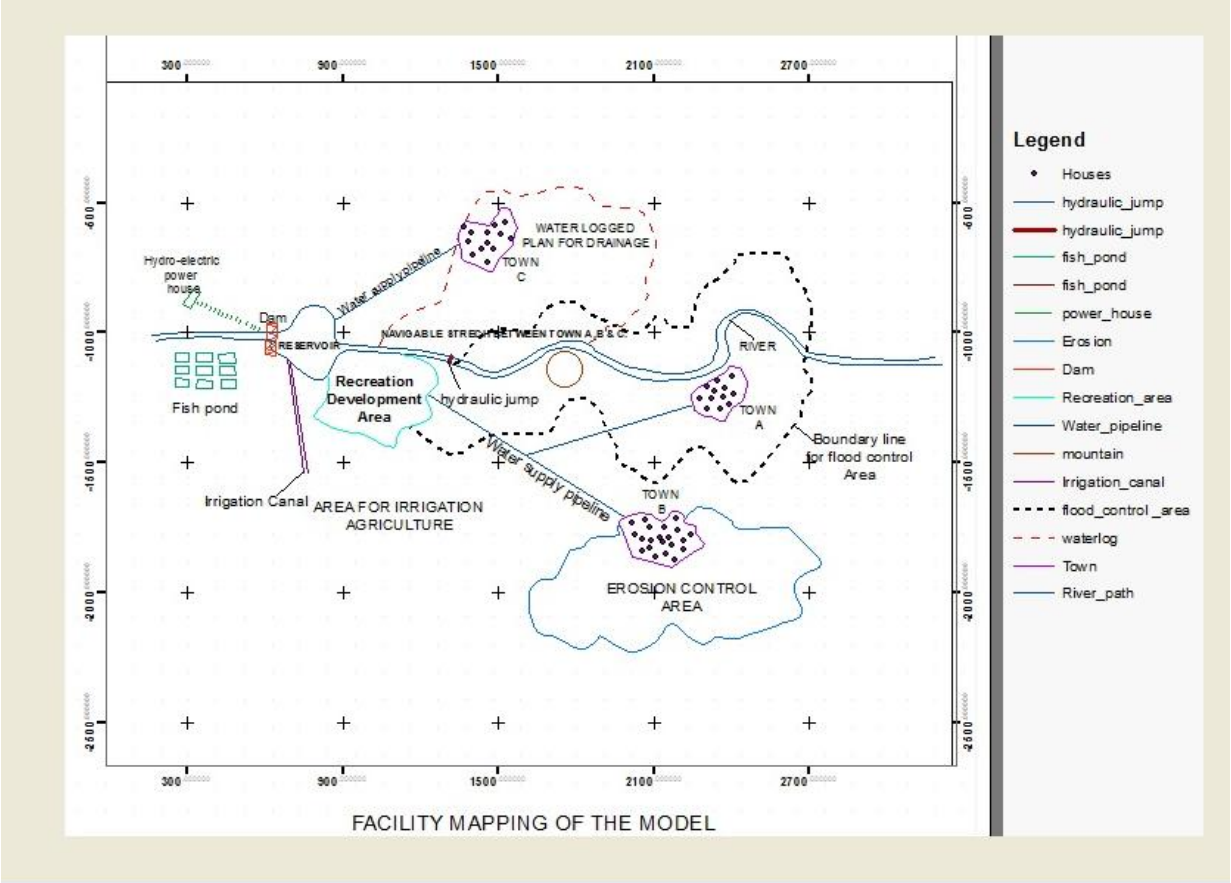


**Figure 10.Showing facility mapping of the model**

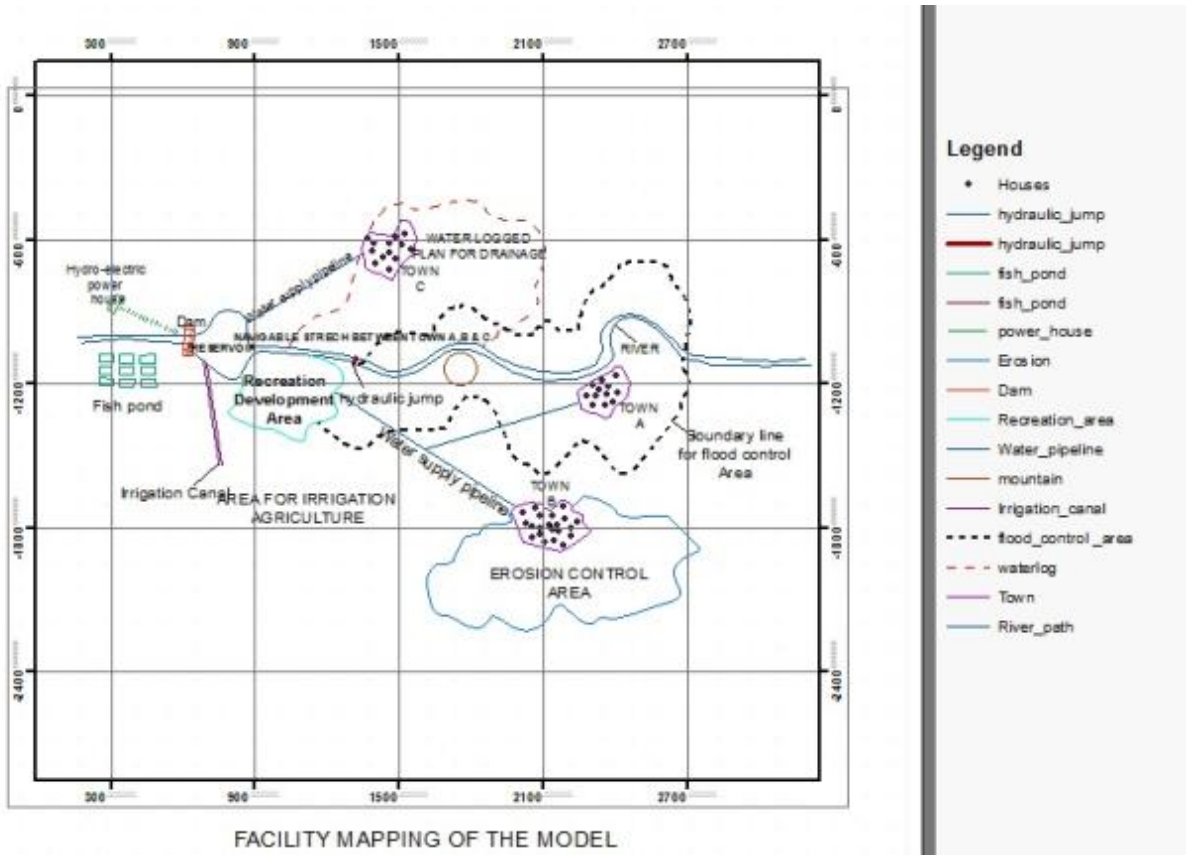


**Figure 11.Showing gridding of facility map**

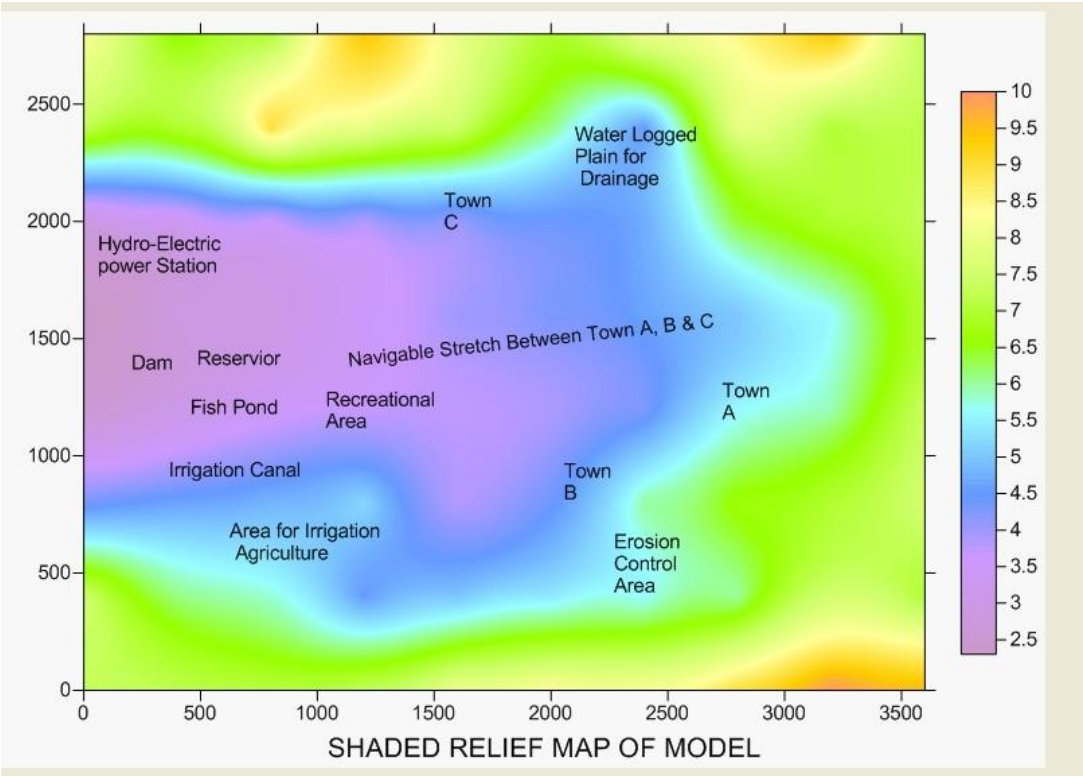


**Figure 12. Showing shaded relief map of the model**

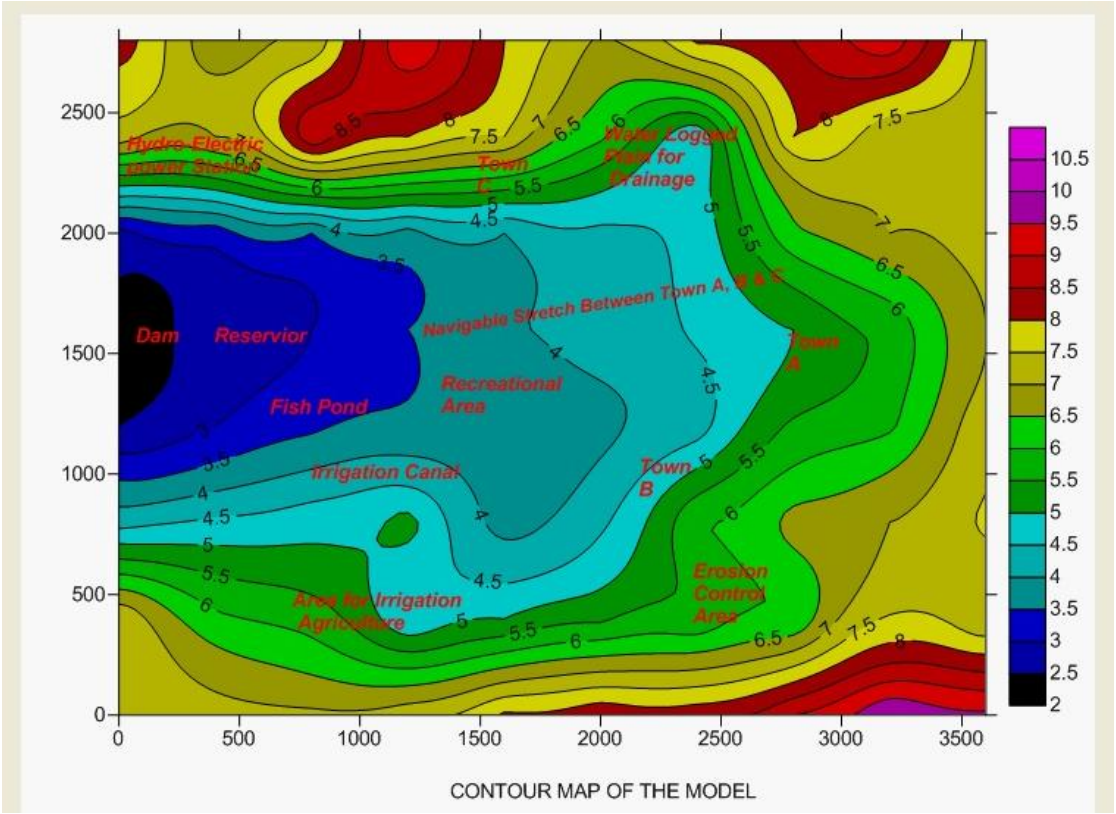


**Figure 13.Showing the contour map of the area**

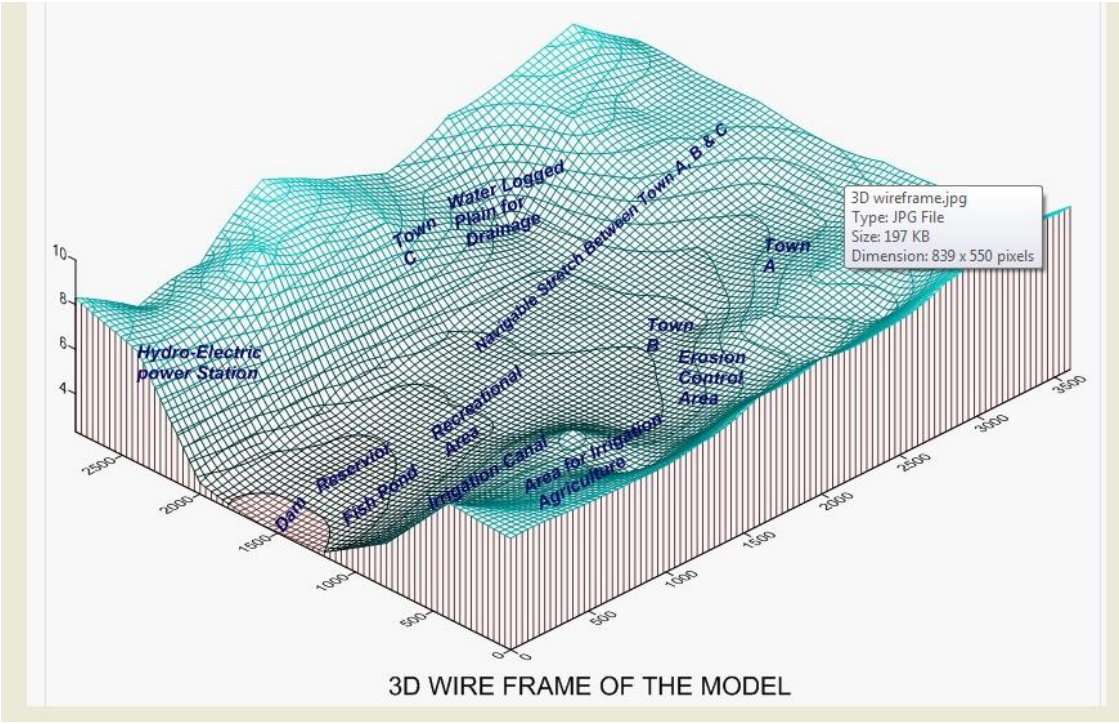


**Figure 14.Showing 3D wire frame of the final model**

## III. RESULTS AND DISCUSSION

Results of hypothetical modeling of a multipurpose multi objective river basin project are presented below.

**Result of hypothetical modeling of a multipurpose multi objective river basin project**

**Figure 15. Top view showing the entire River Basin.**

**Discussion of results in figure 15 above**

i. The simulated model in this research is applicable in river basin optimization. A hypothetical multipurpose project development in a river basin area was modeled to effectively demonstrate its application in river basin optimization.
ii. The model was developed using Civil 3D, AutoCAD and Archicad.
iii. Different views of the model were also presented.

**Result of Digitized Hypothetical Model of a Multipurpose Multi Objective River Basin Project.**

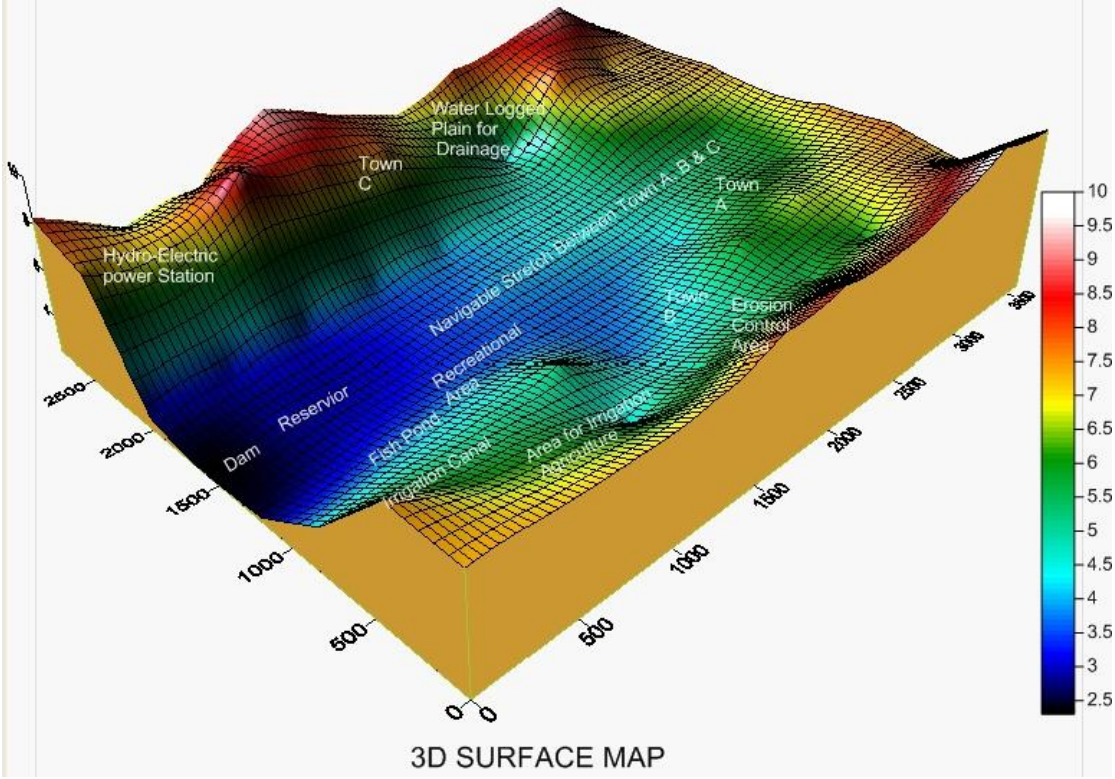


**Figure 16. Showing the final 3D surface Map of the model**

**Discussion of results in figure 16 above**

i. Figure 16 is the 3D surface map of the digitized hypothetical model.

ii. The model showed the three communities A, B, and C with strategic multipurpose multi objective projects which includes hydroelectric power station, fish pond, irrigation canal, erosion and flood control, recreation, navigable surface , dam and reservoir for water supply scheme.

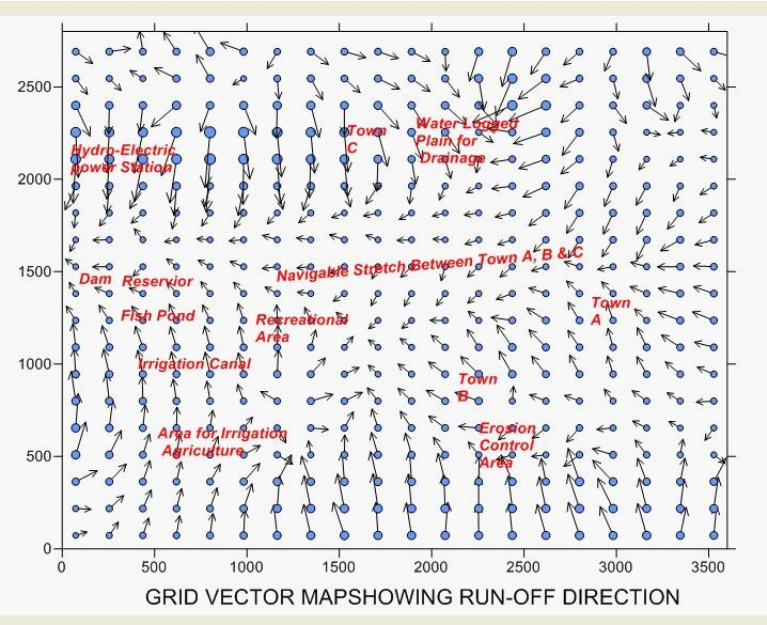


**Figure 17. Showing the grid vector map of run-off direction**

**Discussion of results in figure 17 above**

i. Digital elevation model of hypothetical multi-purpose project was done using Arc view GIS and Sufer 10.
ii. The digitized mapped out model area, facility mapping of the model and gridding of the facility map were done using arc GIS.
iii. Sufer 10 was used to develop other models showing shaded relief map of the model, contour map of the area, 3D wire frame of the final model, final 3D surface Map of the model and grid vector map of run-off direction.

## IV. CONCLUSION

A hypothetical multipurpose multi objective projects development in a river basin area was modeled to effectively demonstrate the application of new simulated model in river basin optimization. Different views of the model were developed using Civil 3D, AutoCAD and Archicad.

Figure 16 is the 3D surface map of the digitized hypothetical model which showed the three communities A, B, and C with strategic multipurpose multi objective projects which includes hydroelectric Power station, fish pond, irrigation canal, erosion and flood control, recreation, navigable surface , dam and reservoir for water supply scheme. The digital elevation model of the hypothetical multipurpose project was done using Arc view GIS and Sufer 10. Suffer 10 was used to develop other models showing shaded relief map of the model, contour map of the area, 3D wire frame of the final model, final 3D surface Map of the model and grid vector map of run-off direction.

Figure 17 showed grid vector map of runoff direction. The map informed water resources managers on best sites to locate lucrative water resources projects that will yield optimal benefit as shown in the map.

## V. RECOMMENDATION

The following recommendations should be implemented.

Ministry of power, agriculture, tourism, and water resources should adopt the use of the simulated model in view of the fact that all the water resources management projects can be properly planned based on ISO 9001:2018 requirement.

## VI. CONTRIBUTION TO KNOWLEDGE

Digital elevation model like this will help in simulating hydraulic jump models, develop optimization model of multipurpose multi objective river basin projects.

## REFERENCES

[1]. Akpan & Ledogo (2015). Hydraulic Jump Modeling and Programing in Visual Basic, International Journal of Hydrauiic Engineering, 4 (2)

[2]. Ahmad I., Zhang F., Liu J., Naveed M., Zaman M., Tayyab M. , Waseem M. & Umar H. (2018) A linear bi-level multi-objective program for optimal allocation of water resources, PLOS One , Received: July 9, 2017; Accepted: January 22, 2018; Published: February 14, 2018.https://doi.org/10.1371/journal.pone.0192294 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0192294#abstract0

[3]. Legogo, A. B. (2012).Terrain Model Of Bori Town for Drainage Management, Using GIS technologies. Master degree thesis. Department of Civil Engineering. University of Port Harcourt.

[4]. Mousavi J.,Nasrin Rafiee N., Asl-Rousta B. & Kim J. (2017) Multi-Objective Optimization-Simulation for Reliability-Based Inter-Basin Water Allocation,Water Resour Manage (2017) 31: 3445. https://doi.org/10.1007/s11269-017-1678-6

[5]. Okada N. (2015) Cost Allocation in Multi-Purpose Reservoir Development, ElsevierIFAC ,PLoS One,v.10(10); 2015,Proceedings Volumes,Volume 14, Issue 2, August 1981, Pages 3879-3885https://doi.org/10.1016/S1474-6670(17)64053-9Get rights and content https://www.sciencedirect.com/science/article/pii/S1474667017640539

[6]. Orton, R. (2012) What is model. Starting point – Teaching entry level, Geoscience. Retreived from http://www. brc.dcs. gla. Ac. Uk/…/modelling) 050301 – Richardordon6up. PDF)