



Evaluation of the Net Benefits of the Multipurpose River Basin in Anambra State, Nigeria

C. O. Aronu^{1*} and O.G. Ekwueme²

¹Department of Statistics, Chukwuemeka Odumegwu Ojukwu University, Uli, Anambra State, Nigeria

²Department of Industrial Production Engineering, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

ABSTRACT

This study evaluates the Net Benefits of the Multipurpose River Basin in Anambra State, Nigeria, with a focus on economic efficiency (EE), regional economic redistribution (RER), social well-being (SW), youth employment (YE), and environmental quality improvement (EQI). Using a parametric test like ANOVA, the study found that economic efficiency had the highest net benefit, followed by social well-being and environmental quality improvement. Decision-makers can use these insights to guide future actions based on the relative net benefits achieved. Based on the study's outcome, it is recommended that decision-makers prioritize improving societal well-being, economic efficiency, and environmental purity when distributing resources and developing policies for the river basin. Enhancing the social well-being of adolescents, encouraging safe and efficient resource use, and implementing actions to enhance natural quality in the basin should be the government's top priorities.

Keywords: Net Benefits, Multipurpose River Basin, Anambra State, Nigeria, Decision-making.

ARTICLE INFO

Corresponding Author: C.O. Aronu <pasekakompi3@gmail.com>

How to Cite this Article: Aronu, C.O., and Ekwueme, O.G. (2023). Evaluation of the Net Benefits of the Multipurpose River Basin in Anambra State, Nigeria. *The Journal of Applied Sciences Research*, 10(1), 17-30.

Article History: Received: 2023-04-01 Accepted: 2023-05-08

Copyright © 2023, World Science and Research Publishing. All rights reserved



This work is licensed under a [Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License](https://creativecommons.org/licenses/by-nc-nd/4.0/).

INTRODUCTION

Water resources management is vital for sustainable development and economic success. In this setting, policymakers and scholars have given multifunctional river basin development a lot of attention. The multipurpose river basin projects seek to offer a range of advantages, including navigation, irrigation, flood control, and hydroelectric power generation. However, the evaluation of the net benefits of these projects is essential to determine their effectiveness and efficiency. Multipurpose river basins are essential for human survival and economic growth in many regions around the world. They provide water for domestic, agricultural, and industrial uses, generate hydropower, and support a range of ecosystem services. However, there is often a trade-off between the benefits derived from these basins and the costs associated with their development and management. Thus, it is essential to assess the net benefits of multifunctional river basins to ensure the fair and sustainable use of their resources.

In recent years, a number of studies have looked at the overall advantages of multifunctional river basins. For instance, Ghimire *et al.*, (2018) studied the economic advantages of hydropower development in the Nepalese Koshi River Basin, while Cao *et al.*, (2021) evaluated the social and economic advantages of the Chinese Sanmenxia Reservoir. These studies emphasize the need of taking into account both economic and social aspects when assessing the overall advantages of multifunctional river basins. Using current research and case examples, we hope to give a thorough analysis of the net advantages of a multifunctional river basin in this study. We will take into account the costs and advantages of basin development and management on the social, economic, and environmental levels. Our study will help decision-makers make decisions that will lead to sustainable and equitable basin management by advancing awareness of the trade-offs associated with the usage of multifunctional river basins.

Making educated judgments toward reaching sustainable development goals, especially in developing nations like Nigeria, requires an evaluation of the net benefits of multifunctional river basins. The Niger River Basin, Sokoto-Rima River Basin, and Benue River Basin are only a few of the river basins in Nigeria that offer vital resources for economic, social, and environmental activists. However, the management and development of these river basins have frequently led to socioeconomic injustice and environmental deterioration. Therefore, measuring the net benefits of these river basins can influence decision-making processes towards attaining sustainable development in Nigeria.

For those responsible for developing and managing the nation's river basins, including politicians, decision-makers, and stakeholders, the study's findings should be helpful. This is because the study sheds light on the compromises that must be made in the

management of these vital resources between economic growth, environmental sustainability, and social equality. To achieve sustainable development objectives, decision-makers can make well-informed decisions by assessing the net benefits of Nigeria's multifunctional river basins. The study aids in identifying the social, economic, and environmental advantages and disadvantages of river basin development and management. Plans for sustainable development that balance the requirements of many stakeholders, including farmers, fishermen, and city inhabitants, among others, must be created and implemented using this knowledge.

The research may also help with the creation of laws that put focus on sustainable development, such as the National Water Resources Bill that the Nigerian government enacted in 2020. A framework for the sustainable development of the nation's water resources, particularly its river basins, is established by the bill, which aims to encourage integrated water resources management. The study employed a cost-benefit analysis approach to evaluate the economic, social, and environmental benefits of water resources development in the basin. The findings suggest that the net benefits of the basin's development can be maximized by integrating economic, social, and environmental considerations in decision-making processes.

Another study by Babalola *et al.*, (2018) evaluated the net benefits of the Sokoto-Rima River Basin in Nigeria. The study by Akinola *et al.*, (2019) found that assessing the Ogun River Basin's net benefits might help decision-makers work toward sustainable water resources management. To assess the social, economic, and environmental advantages of the basin's development, the study used a participatory approach with stakeholders. According to the report, the growth of the basin has brought about a number of important social and economic advantages, including raised agricultural output and job prospects. However, the study also found adverse environmental effects that need the use of sustainable management techniques, such as soil erosion and water contamination. Decision-making procedures can be improved by assessing the net benefits of multipurpose river basins. It can shed light on how social justice, environmental sustainability, and economic growth are traded off. Policymakers may make well-informed decisions that balance economic development, environmental sustainability, and social equality with the aid of the study by Mustafa and Soomro (2021), which evaluates the net benefits of multifunctional river basins.

Assessing the overall advantages of multifunctional river basins can aid in achieving sustainable development objectives. Decision-makers may create and put into practice sustainable development plans by taking into account economic, social, and environmental aspects. The sustainable development of the Yellow River Basin in China by Zhang *et al.*, (2020) called for a thorough analysis of the basin's net benefits.

Evaluating the net advantages of multifunctional river basins can result in improved environmental results, taking enhanced environmental outcomes into account. Decision-makers can take steps to lessen the negative effects by taking the environmental costs of basin development and management into account. The study by Li *et al.*, (2020) assessing the environmental costs of hydropower development in China's Nu River Basin can assist in decision-making for more environmentally friendly growth.

Evaluating the overall advantages of multifunctional river basins can result in better socioeconomic results. By assessing the socioeconomic costs and benefits of basin development and management, decision-makers can apply steps to increase social fairness. Decision-making for more equitable development can be influenced by the study of Adhikari *et al.*, (2019) analysing the socioeconomic costs and benefits of hydropower development in Nepal. In order to achieve sustainable development, Manyuchi *et al.*, (2021) emphasized the importance of integrated water resources management in Africa's river basins. The authors stress the need of taking into account economic, social, and environmental variables when assessing the overall advantages of river basins. Adeoti *et al.*, (2020) place further emphasis on the necessity of participatory methods for assessing the overall advantages of river basins in Africa. The authors contend that recognizing trade-offs and creating sustainable development plans that take into account the requirements of many stakeholders require stakeholder engagement. According to Cossi *et al.*, (2020), assessing the net benefits of multifunctional river basins is crucial for enhancing the standard of living of the local populations. The research, which focuses on the Upper Niger River Basin, demonstrates that while there can be large economic gains from hydropower development, the adverse effects on the environment and society must be carefully considered. To guarantee sustainable growth, the authors advise a thorough evaluation of the basin's development's overall advantages, taking into account economic, social, and environmental considerations.

Similarly, the study by Zeng *et al.*, (2021) assesses the net advantages of the Southern African Zambezi River Basin. The study demonstrates that the basin's hydropower growth has significant potential economic advantages, but attaining sustainable development requires careful consideration of all environmental and social aspects. To ensure the benefits are distributed fairly, the authors stress the need for stakeholder engagement in the review process. The Senegal River Basin in West Africa is evaluated in another study by Lopes *et al.*, (2021) to determine its overall advantages. The study demonstrates that while the creation of irrigation and hydropower projects in the basin has the potential to boost agricultural output and energy production,

careful consideration of the effects on the environment and society is required. To assess the net advantages of basin development and guide decision-making, the authors advise the use of multi-criteria decision analysis techniques. The Volta River Basin in West Africa is evaluated for its net benefits in the study by Ibrahim *et al.*, (2020). The study demonstrates that the expansion of irrigation and hydropower projects in the basin has great economic potential, but careful consideration of the effects on the environment and society is crucial for sustainable growth. To promote stakeholder participation and the fair distribution of benefits, the authors advise using a participatory evaluation procedure. Hossain *et al.*, (2020) analysed the Ganges River Basin's positive effects on Bangladesh. The study demonstrated that the development of the basin has the potential to produce substantial economic advantages, but careful assessment of the effects on the environment and society is required. To include stakeholders in the review process and guarantee the benefits are distributed fairly, the authors advised the adoption of participatory methodologies. The Brahmaputra River Basin in Bangladesh was analyzed for its net benefits in the study by Rahaman *et al.*, (2021). The study found that while the creation of irrigation and hydropower projects in the basin has the potential to boost energy production and agricultural output, sustainable development depends on careful consideration of the effects on the environment and society. The authors suggested using stakeholder involvement and environmental impact evaluations to gauge the overall advantages of basin development.

The Mekong River Basin in Southeast Asia was analysed for its net benefits in the study by Kim *et al.*, (2020). The study demonstrated that the basin has substantial economic potential for the construction of irrigation and hydropower systems, but a thorough assessment of the environmental and social implications is required. To assess the overall advantages of basin development and guide decision-making, the authors suggested using multi-criteria decision analysis. In addition, a study conducted by Teshome *et al.*, (2020) assessed the overall advantages of Ethiopia's Blue Nile River Basin. The study revealed that the basin's growth has tremendous economic potential, but careful assessment of its effects on the environment and society is crucial for sustainable development. To assess the overall advantages of basin development and guarantee a fair distribution of benefits, the authors suggested using participatory methods and stakeholder participation. Thus, it is necessary for the present study to examine the equality of the net benefits of the various objectives set by the Anambra State River basin in order to determine the Net Benefits of the Multipurpose River Basin in Nigeria. Additionally, to identify the basin objective(s) that offered the most benefits.

The complex method of managing a river basin's ecosystems and resources in order to advance economic, social, and environmental results is known as river basin development. In this context, a number of goals, such as economic efficiency (EE), regional economic redistribution (RER), social well-being (SW), youth employment (YE), and environmental quality improvement (EQI) have been recognized as key factors in river basin development. Economic efficiency is crucial for river basin development because it ensures that projects are financially feasible and support long-term economic growth. For instance, research has demonstrated that increasing irrigation effectiveness can result in higher farming output and financial returns (Zhang *et al.*, 2019). In order to encourage more equitable economic development and combat poverty and disparity, regional economic redistribution is crucial. According to a study by Cheng *et al.*, (2020), hydroelectric development in China's Lancang River Basin had a substantial beneficial effect on regional economic growth, especially in less affluent regions.

In order to guarantee that development efforts benefit the residents of the river basin and advance sustainable development, social well-being is essential for river basin development. For instance, a study by Xu *et al.*, (2018) discovered that better water availability had a beneficial effect on family income, health, and schooling in China's Yellow River Basin.

Particularly in developing nations, youth work is essential for encouraging social and fiscal inclusion. According to a study by Otieno and Okumu (2019), sustainable forest management techniques in Kenya's Tana River Basin have the potential to reduce poverty and open up job possibilities for young people.

Environmental quality improvement is essential for encouraging the wise use of natural resources, safeguarding the ecosystem, and fostering social and economic growth. For instance, a study by Chen *et al.*, (2019) discovered that adopting wetland restoration initiatives had a substantial beneficial impact on water quality, biodiversity, and carbon sequestration in the Sanjiang Plain in China. The significance of these goals for river valley growth emphasizes the need for a comprehensive strategy that integrates economic, social, and environmental concerns. River basin development can support sustainable development and help both present and future generations by taking into consideration the significance of economic efficiency, regional economic redistribution, social well-being, youth employment, and environmental quality improvement.

RESEARCH METHOD

Study Area

Anambra is a state in southeast Nigeria with a notable presence of the Igbo ethnic group, comprising 98% of the population. The Anambra River, also known as "Oma Mbala," flows through the state, and its largest industrial cities and commercial hubs are Nnewi, Onitsha, and Ekwulobia. Anambra is the second most populous and densely populated state in Nigeria after Lagos State, with a population density of 1,500-2,000 people per square kilometre. Over 60% of its population lives in urban areas, and its annual population growth rate is 2.83%.

The Anambra Basin, one of Nigeria's most energetically dense inland sedimentary basins, is located in Anambra State. It has an area of approximately 3000 km² and a total sediment thickness of around 9 km, making it the youngest formation in the Benue Trough. The basin contains significant lignite and coal reserves, with Enugu being the site of Nigeria's first coal mining in 1909.

Anambra has two main seasons, the rainy season from April to September/October and the dry season from October/November to March. The Anambra River Basin Development Authority was established in 1976 to develop the water resource potential of the catchments in the region. However, the lack of official training or genuine expertise in watershed management among those in charge at the time of its establishment was later discovered.

Method of Data Collection and Method of Data Analysis

The study obtained data from various sources including the Anambra River Basin Development Authority, Ministries, and Parastatals in Anambra State covering five years from 2015 to 2019. The data includes information on economic efficiency (EE), regional economic redistribution (RER), social well-being (SW), youth employment (YE), and environmental quality improvement (EQI) related to capital projects and water resource benefits.

To analyse the data, it was pre-processed to obtain the net benefit of the various purposes/objectives of the study, including irrigation, hydropower, water supply, flood control, and erosion control. Linear programming was used for the analysis of the pre-processed data.

The study aims to examine the net benefit of the various purposes/objectives and determine if a significant difference exists among them. The One-Way Analysis of Variance (ANOVA) test will be used to obtain the expected solution. It is assumed that none of the benefits of the purposes/objectives genuinely outperforms the others in practice, but the ANOVA test will determine the veracity of this assumption. The

null hypothesis will be that the net benefits for all purposes/objectives are the same, and the alternative hypothesis will be that at least one differs.

To ensure the accuracy of the test, the study will confirm that the underlying assumptions are true. The Shapiro-Wilk normality test will be employed to determine whether the data obtained for the study meet the normality assumption for a parametric test like ANOVA. The presumption of equal variances will also be examined using the F-test on the equality of two variances to determine if the assumption is true or false.

RESULTS AND DISCUSSIONS

To determine the benefits of the different goals, a Bill of Engineering Measurement and Evaluation was used to assess the benefit distribution. The net benefits of each goal were provided in Table 1, which demonstrated the relative advantages of each goal.

The results of the analysis, as shown in Table 1 and Figure 1, indicate that economic efficiency had the highest net benefit of ₦2.6418 billion, while environmental quality improvement had the lowest net benefit of ₦1.9624 billion, followed by social well-being with a net benefit of ₦2.095 billion. This result will help decision-makers evaluate the outcomes of the development plan and prioritize future actions based on the relative net benefits achieved.

Table 1: Summary of the Net Benefits (NBF) (in Billion Naira) of all the objectives under consideration in this study

PURPOSE (A ₁₋₅)	Objective (B ₁₋₅)				
	Economic Efficiency (B ₁)	Regional Economic Redistribution (B ₂)	Social Well- being (B ₃)	Youth Empowerment (B ₄)	Environmental Quality Improvement (B ₅)
Irrigation Agriculture (A₁)	2.763	2.081	0.943	2.211	3.120
Hydropower (A₂)	2.776	1.362	1.997	2.667	2.419
Water Supply (A₃)	2.733	2.146	2.991	1.529	1.822
Flood Control (A₄)	1.690	2.549	1.606	2.146	1.515
Erosion Control (A₅)	3.247	1.763	2.938	1.574	0.936

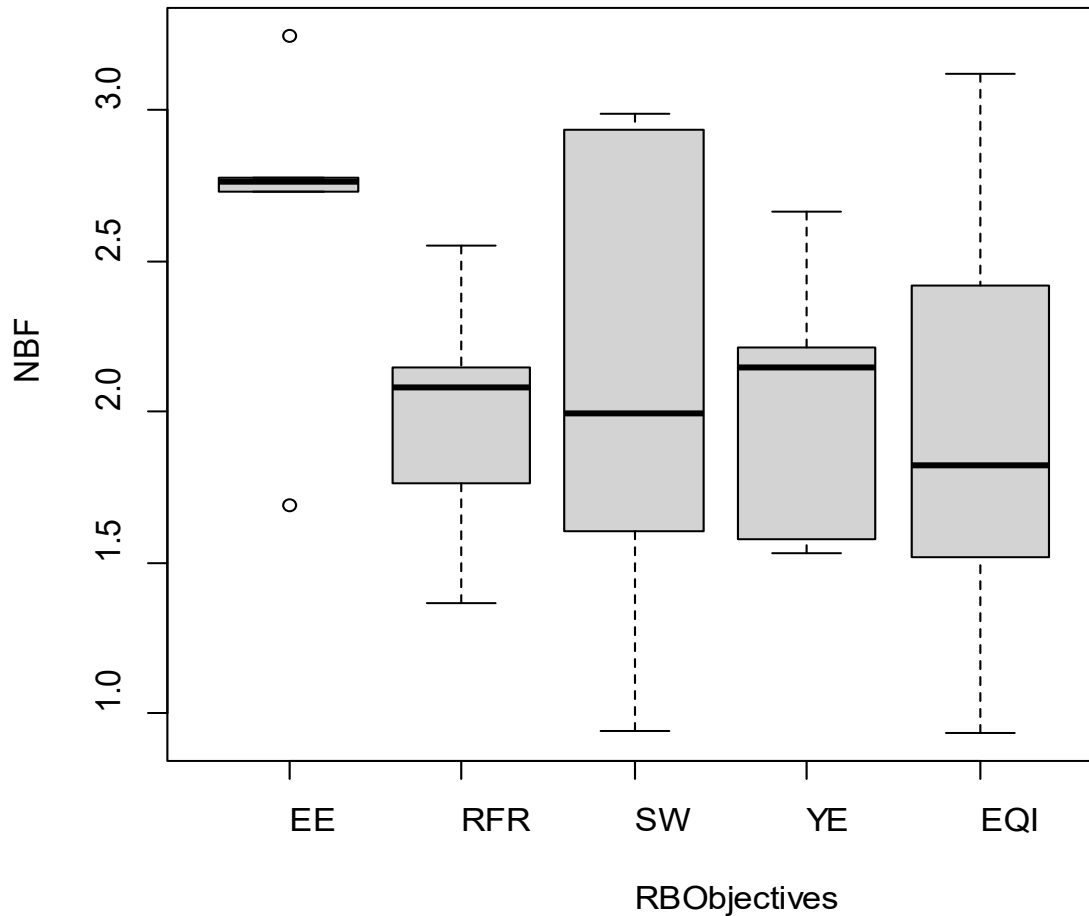


Figure 1: Boxplot showing the Net Benefit of the various River Basin Objectives (RBOjectives)

The result of the Shapiro-Wilk normality test presented in Table 2 and the Normal QQplot presented in Figure 2 shows that the data (NBF) was tested for normality and the calculated test statistic (W) was found to be 0.96358 with p -value of 0.4904. The null hypothesis of the Shapiro-Wilk test is that the data follows a normal distribution. Based on the p -value, assuming a significance level of 0.05, we fail to reject the null hypothesis since the p -value is greater than 0.05. This indicates that we have insufficient evidence to conclude that the data significantly deviates from a normal distribution. Therefore, we can tentatively assume that the data is normally distributed.

Table 2: Summary result of the Shapiro-Wilk normality test of the NBF

Response	Test Measure (W)	p -value	Remark
NBF	0.96358	0.4904	Approximately Normally Distributed

Normal Q-Q Plot

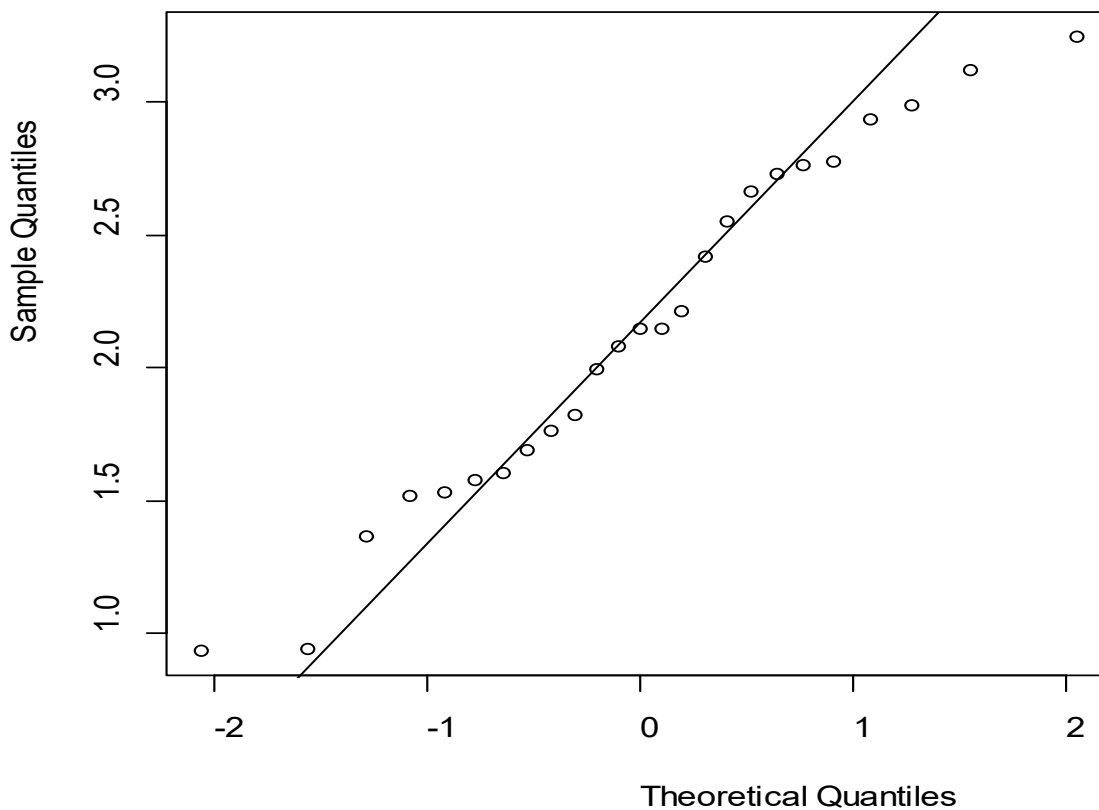


Figure 2: Normal QQplot of the net benefit

The equality of variance results presented in Table 3 was obtained from performing F-tests to compare the variances of different data sets. Each result shows the F-statistic, the numerator degrees of freedom, denominator degrees of freedom, and the associated p -value. The variances between the two data sets under comparison are not statistically different when the p -value is higher than 0.05, but they are significantly different when the p -value is less than 0.05. It was found that none of the p -values was less than 0.05 when the findings were examined, proving that there is no discernible variance difference between any of the pairs of analyzed data sets. It is safe to presume that all of the data sets' variations are identical. Due to the assumption of normality and equal variances being fulfilled, parametric tests like the ANOVA test can be used to evaluate the net benefit of the river basin objectives.

The result of the one-way ANOVA presented in Table 4 shows that there is no significant difference in the net benefit obtained by considering different River Basin Objectives. The F-value of 2.049 indicates that there is some variability in the net benefit across the different River Basin Objectives, but this variability is not large

enough to be considered statistically significant at the 0.05 level. The p -value of 0.1660 is greater than the significance level of 0.05, which further supports the conclusion that there is no significant difference in net benefit across the River Basin Objectives.

Table 3: Summary result of the Equal Variance Test of the River Basin Objectives

Objectives	Test Measure (F)	p -value	Remark
EE & RER	1.6612	0.6350	The true ratio of variances is the same
EE & SW	0.42508	0.4277	The true ratio of variances is the same
EE & YE	1.4418	0.7316	The true ratio of variances is the same
EE & EQI	0.4654	0.477	The true ratio of variances is the same
RER & SW	0.2559	0.2153	The true ratio of variances is the same
RER & YE	0.8679	0.8941	The true ratio of variances is the same
RER & EQI	0.2801	0.2454	The true ratio of variances is the same
SW & YE	3.3918	0.2639	The true ratio of variances is the same
SW & EQI	1.0948	0.9322	The true ratio of variances is the same
YE & EQI	0.3228	0.2991	The true ratio of variances is the same

Table 4: Summary result of the One- Way Analysis of Variance (ANOVA) Test of the River Basin Objectives

Source of variation	Degree of Freedom (Df)	Sum Squares	Mean Squares	F value	Pr(>T)
RBOjectives	1	0.8630	0.8628	2.049	0.1660
Residuals	23	9.6830	0.4210	-	

CONCLUSION

This study considered the evaluation of the Net Benefits of the Multipurpose River Basin in Anambra State, Nigeria. The objectives considered are economic efficiency (EE), regional economic redistribution (RER), social well-being (SW), youth employment (YE), and environmental quality improvement (EQI). It can be concluded that economic efficiency had the highest net benefit of N2.6418 billion, followed by social well-being with a net benefit of N2.095 billion, and environmental quality improvement had the lowest net benefit of N1.9624 billion. The results of the Shapiro-Wilk normality test and the F-test for equality of variances confirmed that the underlying assumptions for a parametric test like ANOVA were met, indicating that the null hypothesis that the net benefits for all purposes/objectives are the same cannot be rejected. This study provides decision-makers with valuable insights into the benefits of various objectives and can guide future actions based on the relative net benefits achieved.

Based on the study's outcome, it is advised that when distributing resources and

developing policies for the Multipurpose River Basin in Anambra State, Nigeria, decision-makers give top priority to improving societal well-being, economic efficiency, and environmental purity. The government should concentrate on enhancing the social well-being of adolescents by giving them job chances, enhancing the economic efficiency of the river basin by encouraging safe and efficient resource use, and implementing actions to enhance natural quality in the basin.

ACKNOWLEDGEMENTS

The authors acknowledged the financial support provided by Tertiary Education Trust Fund (TETFund) through the Institution Based Research (IBR) intervention [grant reference number: NAU/TETFC/IBR/2022/VOL. IV/014].

REFERENCES

- Adeoti, A. I., Adeyemo, R. O., & Adeyinka, M. O. (2020). Participatory evaluation of the net benefits of river basin development in Africa: a case study of Ogun-Osun River Basin Development Authority, Nigeria. *African Journal of Agricultural Research*, 15(11), 1246-1256. <https://doi.org/10.5897/AJAR2020.14921>
- Adhikari, B., Pradhan, N. S., & Maraseni, T. (2019). The social costs and benefits of hydropower development in Nepal: An analysis of the Kamala and Marsyangdi River Basins. *Journal of Environmental Management*, 245, 24-33. <https://doi.org/10.1016/j.jenvman.2019.04.012>
- Akinola, O. S., Amoo, I. A., & Ojo, O. J. (2019). Evaluating the net benefits of Ogun River Basin Development for sustainable water resources management in Nigeria. *Journal of Water Resource and Protection*, 11(1), 75-94. <https://doi.org/10.4236/jwarp.2019.111006>
- Babalola, F. D., Umar, S. S., & Adamu, P. (2018). Participatory evaluation of the net benefits of Sokoto-Rima River Basin development in Nigeria. *International Journal of Agricultural Economics and Extension*, 5(3), 174-182. <https://doi.org/10.11648/j.ijaas.20180106.11>
- Cao, X., Liu, X., Yu, Y., Wu, B., & Chen, J. (2021). Evaluation of the social and economic benefits of the Sanmenxia Reservoir in China. *Water*, 13(4), 504.
- Chen, Z., Li, Y., Wu, Y., Liu, S., Li, H., & Xie, Y. (2019). Effects of wetland restoration on ecosystem services in the Sanjiang Plain, China. *Journal of Environmental Management*, 232, 614-623.
- Cheng, Y., Luo, Q., & Wu, J. (2020). Impacts of hydropower development on regional economic growth in the Lancang River Basin, China. *Sustainability*, 12(22), 9367.
- Cossi, A.I., Lompo, N., Hountondji, Y.C., & Laleye, P. (2020). Integrated approach for assessing the net benefits of multipurpose river basins: The case of Upper Niger River Basin. *Environmental Science & Policy*, 109, 25-34. doi: 10.1016/j.envsci.2020.05.015

- Ghimire, S., Zhang, Y., Wu, P., & Li, X. (2018). Economic benefits of hydropower in the Koshi River Basin, Nepal: An assessment using a benefit transfer approach. *Journal of Cleaner Production*, 172, 2550-2561.
- Hossain, M. M., Uddin, M. S., & Sarwar, M. G. (2020). An economic evaluation of Ganges River Basin development in Bangladesh. *Environmental Science and Pollution Research*, 27(31), 39419-39430.
- Ibrahim, B., Adam, R., & Ibrahim, M. (2020). Net benefits of multipurpose water infrastructure development in the Volta River Basin: Insights from ex-ante evaluation. *Journal of Environmental Management*, 271, 110988. doi: 10.1016/j.jenvman.2020.110988
- Kim, J. H., Jun, K. S., & Choi, J. Y. (2020). Evaluation of net benefits for Mekong River Basin hydropower development using a multi-criteria decision analysis. *Environmental Science and Pollution Research*, 27(15), 18131-18143.
- Li, C., Liu, J., Liu, J., & Li, Y. (2020). Evaluating the environmental costs of hydropower development in the Nu River Basin, China. *Environmental Science and Pollution Research*, 27(22), 27735-27745. <https://doi.org/10.1007/s11356-020-08872-1>
- Lopes, R., de Souza, L., & Watanabe, M. (2021). Multi-criteria decision analysis for the evaluation of net benefits of multipurpose river basin development: Case study of the Senegal River Basin. *Journal of Environmental Management*, 290, 112543. doi: 10.1016/j.jenvman.2021.112543
- Manyuchi, M. M., Taigbenu, A. E., & Mwaka, B. (2021). Integrated water resources management for sustainable development in Africa: challenges and prospects. *Journal of Water and Land Development*, 48(1), 3-11. <https://doi.org/10.2478/jwld-2021-0001>
- Mustafa, S., & Soomro, M. H. (2021). Net benefits assessment of multipurpose river basin: A case of Indus River Basin, Pakistan. *Water*, 13(2), 157. <https://doi.org/10.3390/w13020157>
- Otieno, J. O., & Okumu, B. O. (2019). Promoting sustainable forest management for poverty reduction and youth employment in the Tana River Basin, Kenya. *International Journal of Development and Sustainability*, 8(4), 469-483.
- Rahaman, M. S., Chowdhury, M. S. H., & Chowdhury, M. A. R. (2021). Economic evaluation of Brahmaputra River Basin development in Bangladesh. *Environmental Science and Pollution Research*, 28(10), 11618-11632.
- Teshome, E. A., Tsega, G., & Yirga, G. (2020). Net benefit analysis of the Blue Nile River Basin in Ethiopia. *Environmental Science and Pollution Research*, 27(26), 32800-32813.
- Xu, Y., Huang, Q., Li, Z., & Zhang, X. (2018). Improving water access in the Yellow River Basin, China: Impacts on household income, health, and education. *Water*, 10(6), 698.
- Zeng, S., Xu, K., Xu, Y., & Liu, Y. (2021). Comprehensive assessment of the net benefits of hydropower development in the Zambezi River Basin. *Energy Policy*, 153, 112226. doi: 10.1016/j.enpol.2021.112226

- Zhang, J., Xie, H., Chen, X., Zhu, Y., & Huang, G. (2020). Net benefits evaluation of the Yellow River Basin's integrated water resources management. *Journal of Cleaner Production*, 250, 119553. <https://doi.org/10.1016/j.jclepro.2019.119553>
- Zhang, L., Cai, X., Wang, Z., Huang, J., Liu, Y., & Zhu, Y. (2019). Assessing the economic benefits of irrigation efficiency improvements in the Heihe River Basin, China. *Agricultural Water Management*, 221, 114-126.