Analysis of Under Five Mortality Rate for Uganda Using an Artificial Intelligence Technique

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for Uganda from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation statistics indicate that the applied ANN (12, 12, 1) model is stable in forecasting U5MR. The results of the study indicate that U5MR will remain high throughout the out of sample period. Therefore, Ugandan authorities must address all the factors that significantly contribute to under five mortality across the country.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Planning and budgeting are very essential for the successful implementation of the 2030 Agenda for sustainable development. Sustainable development goals must be incorporated into the regional, national and local government plans and budgets to ensure quick and smooth implementation (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). It is important to respect national laws, cultures, religious beliefs and human rights when implementing SDGs. Monitoring and evaluation tools should be availed at the lowest level to enable timeous data collection. Support and supervision together with technical assistance must be availed regularly. In addition, early surveillance tools like time series forecasting techniques must be utilized to inform policy making, planning and allocation of resources (Zhao *et al.* 2020; Panch *et al.* 2018). In this study we apply the artificial neural network approach to analyze univariate time series data on under five mortality rate in Uganda. The findings are expected to guide maternal and child health policies and allocation of resources with the goal of substantially reducing under five mortality to as low as 25 deaths per 1000 live births by 2030.

II. LITERATURE REVIEW

Gage & Bauhoff (2020) assessed the impact of PBF on early neonatal health outcomes and associated health care utilization and quality in Burundi, Lesotho, Senegal, Zambia and Zimbabwe. Authors utilized data from Demographic and Health Surveys and Multiple Indicator Cluster Surveys and applied difference-in-differences analysis to estimate the effect of PBF projects supported by the World Bank on early neonatal mortality and low birth weight and concluded that PBF had no impact on early neonatal health outcomes in the five African countries studied and had limited and variable effects on the utilization and quality of neonatal health care. A cross-sectional study was carried out in Burundi by Moise (2018) to describe the main causes of hospitalization and mortality in children during the neonatal period and at ages 1 to 59 months, for boys and girls, and to assess the total annual (2010) burden of under-five morbidity and mortality in hospitals using hospitalization records from 21 district hospitals. The study findings indicated that human malarial infections continue to be the main cause of hospitalization and mortality among under-five children in Burundi. Bitew *et al.* 2020 determined predictors and the incidence density rate (IDR) of neonatal mortalities in sub-Saharan countries by utilizing electronic databases (Web of Science, PubMed, EMBASE (Elsevier), Scopus, CINAHL (EBSCOhost), World Cat, Google Scholar, and Google). The study concluded that the incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors. Noori *et al.* 2020 utilized Nanoro HDSS data from 2009 to 2013 to estimate the association between under-5 mortality and accessibility to inpatient and outpatient 38 health facilities in Burkina Faso, seasonality of death, and age group. The study found that significant predictors of under 5 mortality were seasonality of death (wet season greater than dry season) and time taken to reach the health facility.

III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual under five mortality rate for Uganda.

Data Issues

This study is based on annual under five mortality rate in Uganda for the period 1960 – 2020. The out-of-sample forecast covers the period 2021–2030. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

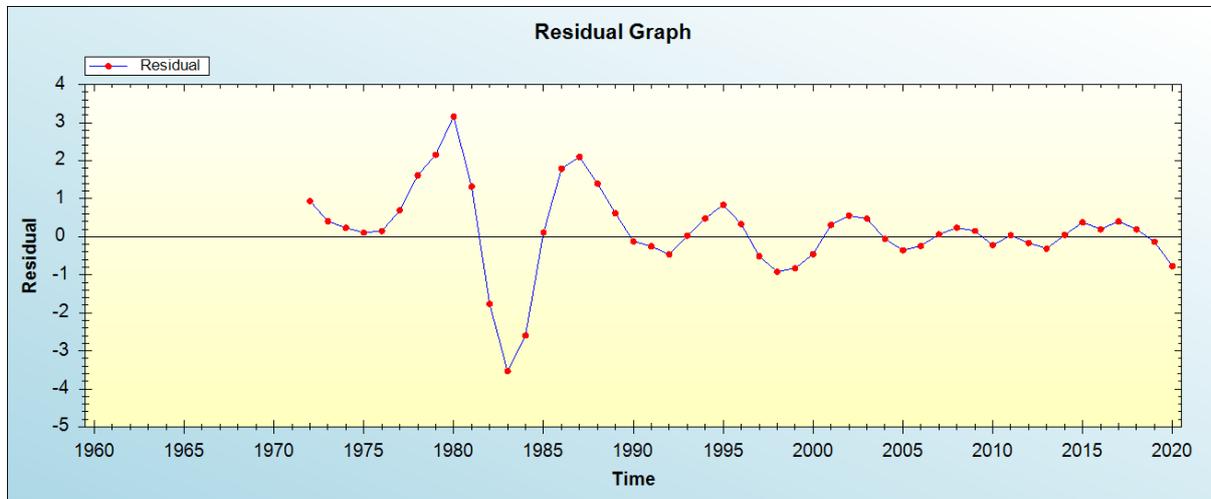| Variable	U
Observations	49 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.003077
MSE	1.190802
MAE	0.719327

Residual Analysis for the Applied Model

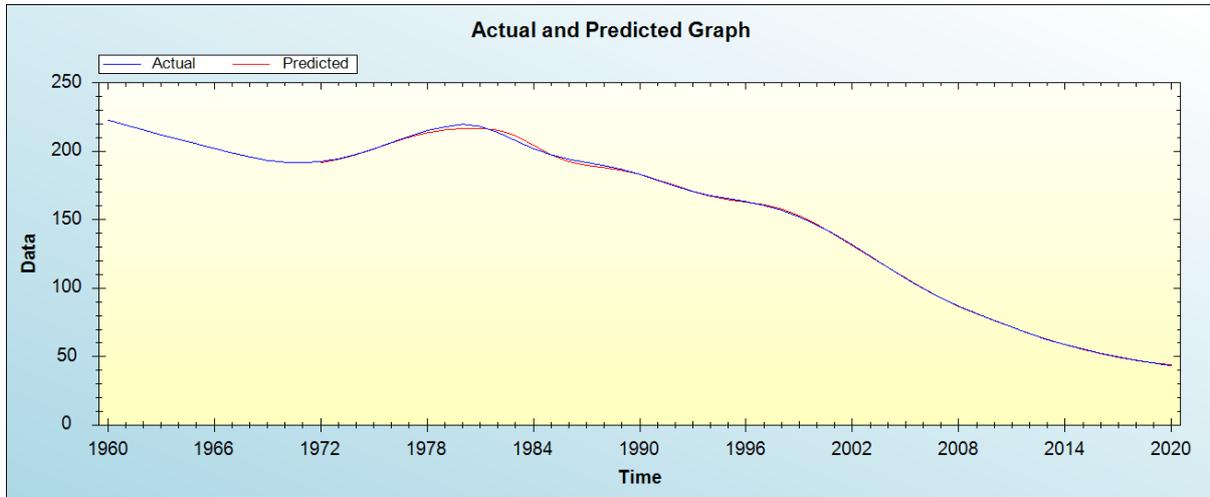Figure 1: Residual analysis

In-sample Forecast for U

Figure 2: In-sample forecast for the U series

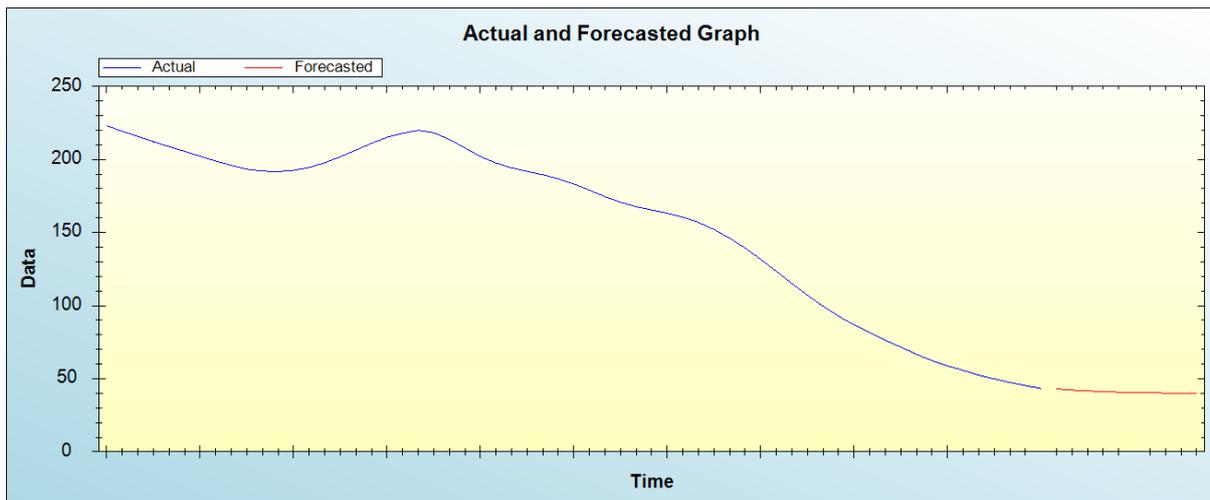Out-of-Sample Forecast for U: Actual and Forecasted Graph

Figure 3: Out-of-sample forecast for U: actual and forecasted graph

Out-of-Sample Forecast for U: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	43.0358
2022	42.2317
2023	41.6826
2024	41.1846
2025	40.8315
2026	40.5758
2027	40.3971
2028	40.2420
2029	40.1387
2030	40.0590

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that annual U5MR will remain high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Uganda has made significant milestones in the reduction of under-five mortality. However, the problem of high numbers of teenage pregnancies contribute significantly to adverse maternal and child health outcomes. Social, cultural, and demographic factors are also among the leading causes of mortality among under five children. The ANN model was applied in this study to analyze under five mortality rate and forecast results revealed thatU5MR will remain high throughout the out of sample period. Therefore, we encourage Ugandan authorities to address all the major challenges that contribute to mortality among under five children.

REFERENCES

[1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.

[2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.

[3] UN (2020) sustainable development goals. https://www.un.org/sustainabl development/development-agenda

[4] UNICEF (2018). Every Child alive. New York: UNICEF

[5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.

[6] Zhao N., Charland K., Carabali M., Elaine O., Nsoesie., MaheuGiroux M., Rees E., Yuan M., Balaguera C G., Ramirez G J., & Zinszer K (2020). Machine learning and dengue forecasting: Comparing random forests and artificial neural networks for predicting dengue burden at national and sub-national scales in Colombia. PLOS Neglected Tropical Diseases | https://doi.org/10.1371/journal.pntd.0008056

[7] Panch T., Szolovits P., & Atun R (2018). Artificial intelligence, machine learning and health systems, 5, 2, 020303.

[8] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

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