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Forecasting the Future Trends of Under Five Mortality Rate for Cote D'lvoire Using Artificial Neural Networks

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***Abstract* - This study uses annual time series data on under five mortality rate for Cote d'lvoire from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and model evaluation criteria of the applied model indicate that the model is stable in forecasting U5MR in Cote d'lvoire. The ANN (12, 12, 1) model projections indicate that U5MR will remain high over the out of sample period. Therefore, we encourage the government to allocate more resources to the maternal and child program. The government should address various challenges that significantly contribute to the death of under five children especially in the rural areas where access to quality healthcare services is a problem.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Ending preventable maternal, neonatal and under five deaths remains a priority for low and middle income countries (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; Alkema *et al*. 2015; Bhutta *et al*. 2013). This phase of sustainable development goals (SDGs) is expected to produce tangible results in terms of eradicating poverty, hunger, and other forms of deprivation (UN, 2016; UN, 2015). All UN member states are expected to demonstrate their commitment by respecting human rights and ending all forms of human rights abuses and ensuring that justice prevails where appropriate (UN, 2015). In addition, developing countries must prioritize ending maternal, newborn and under-five deaths through the implementation of policies that effectively address all the various causes of mortality among pregnant mothers, newborn and children below 5 years. SDG3 is at the core of the Agenda 2030, hence countries should aim at significantly reducing maternal, newborn and under five deaths. The global neonatal mortality rates have decreased from 37 deaths per 1000 live births in 1990 to 18 deaths per 1000 live births in 2018 with Sub-Saharan Africa contributing 41% of the global neonatal deaths (UNICEF *et al*. 2019; Hug *et al*. 2019). In line with the Agenda 2030 for sustainable development, this paper applies the artificial neural network technique to forecast under five mortality rate in Cote d'lvoire. The results of this study will inform MNCH policies and allocation of resources in order to adequately prevent under five mortality in the country.

II. LITERATURE REVIEW

Tesema & Worku (2021) examined the individual and community-level determinants of neonatal mortality in the Emerging regions of Ethiopia. Secondary analysis of the data from the 2016 Ethiopian Demographic and Health Survey (EDHS) was carried out and the findings indicated that Neonatal mortality in Emerging regions of Ethiopia was unacceptably high. A cross-sectional study was conducted in Ethiopia by Bariki *et al.* (2020) examined factors affecting infant mortality among the general population of Ethiopia, 2016. A total of 10,641 live births were included in the analysis. The study applied logistic regression in statistical analysis. The study findings revealed that sex of the child, multiple births, prematurity, and residence were notably associated with infant mortality. The risk of infant mortality has also shown differences across different regions. An Indonesian cross-sectional study conducted by Irawaty *et al.* (2020) investigated predictors of infant mortality in rural Indonesia and suggested strategies for its reduction. The information on infant deaths collected from those mothers who experienced infant deaths. Series of logistic regression models were used to select the significant factors affecting infant mortality in rural Indonesia. It was discovered that infant mortality is associated with intermediate social determinants such as birth order, birth weight, and breastfeeding status. Socio-demographic factors such as the educational status of mothers, wealth quintile, the smoking habit of the mother, age of mother at first delivery, and sex of the baby are also related to infant mortality. A quantitative case control study was conducted by Elida *et al.*(2019) to examine factors that influence infant mortality in West Aceh Regency. A case group was 45 mothers whose babies died when they were under one years old and a control group was 45 mothers whose babies were alive when they were under one year old. The matching was done on the babies based on their age and sex. Logistic regression results revealed that maternal age and parity significantly influence of infant mortality. In the other hand, maternal education did

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not significantly influence infant mortality. The most significant variable which influences infant mortality was maternal age (OR=4.745).

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 Cote d'lvoire.

Data Issues

This study is based on annual under five mortality rate in Cote d'lvoire 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	C
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	0.001085
MSE	0.721490
MAE	0.604005

Residual Analysis for the Applied Model

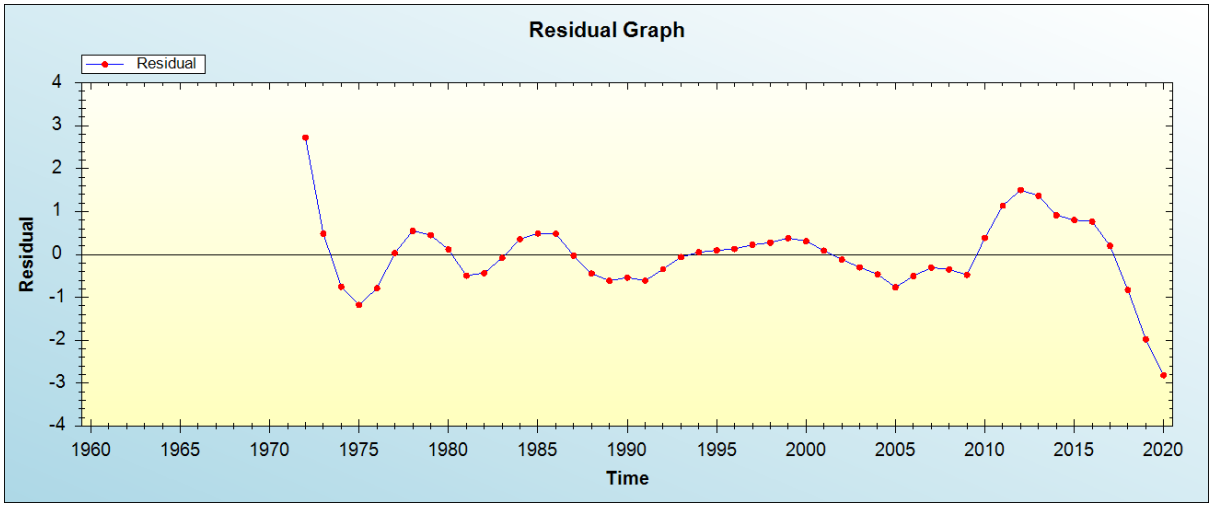

Figure 1: Residual analysis

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In-sample Forecast for C

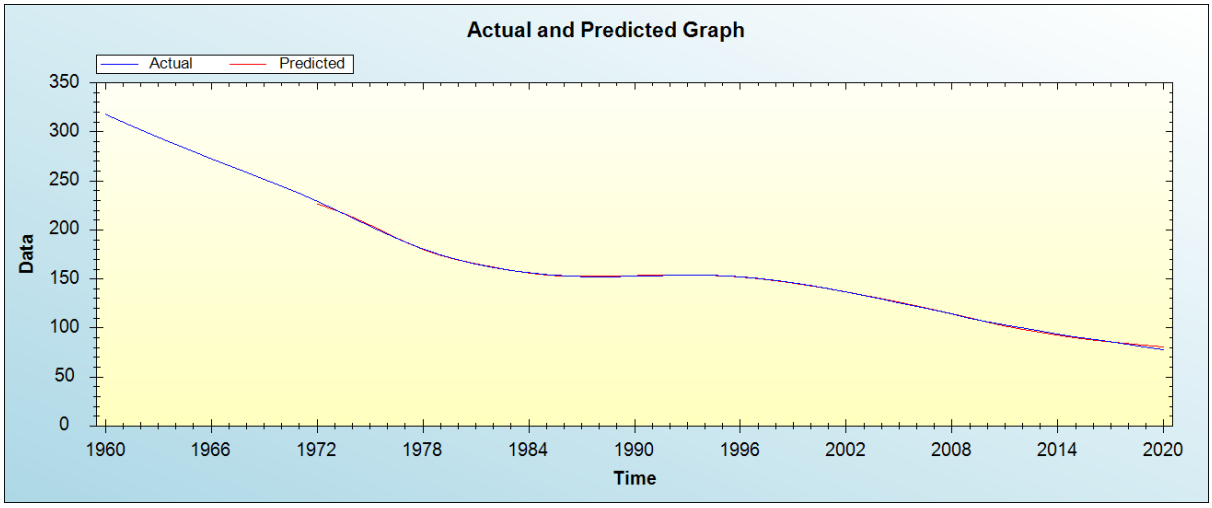

Figure 2: In-sample forecast for the C series

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

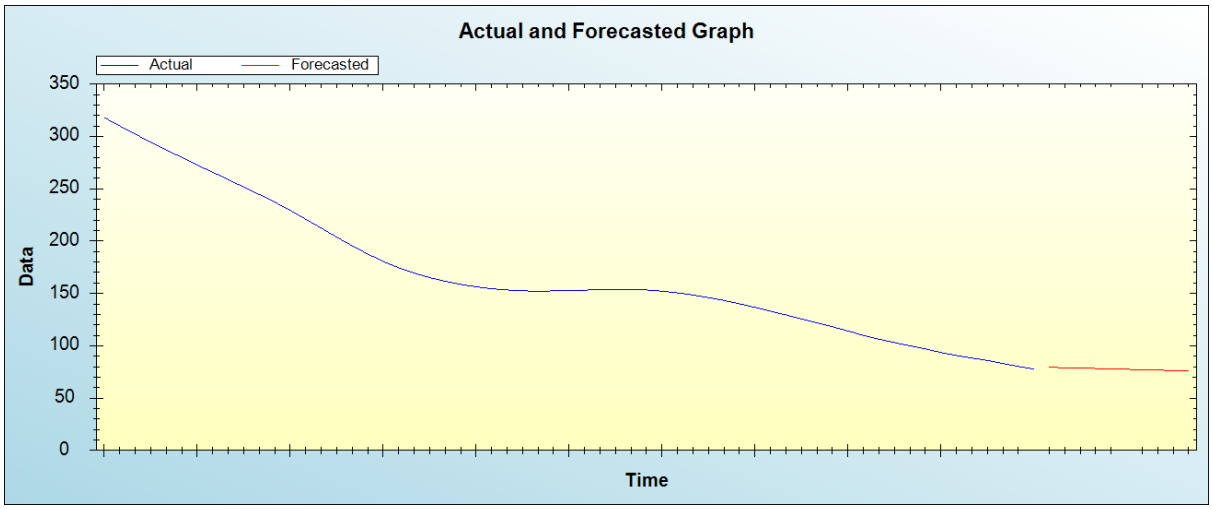

Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	79.4760
2022	79.0961
2023	78.9445
2024	78.3354
2025	77.7988
2026	77.5722
2027	77.1501
2028	76.8490
2029	76.2688
2030	76.0876

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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 over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Mortality among under five children is of major concern in Sub-Saharan Africa with many under five deaths as a result of malnutrition, diarrheal diseases, pneumonia and delayed healthcare interventions. This study applied the artificial neural network technique to predict future trends of under-five mortality in Cote d'lvoire. The findings of the study showed that U5MR will remain high over the out of sample period. Therefore, we encourage the government to allocate more resources to the maternal and child (MNCH) program. There is need to address all the major factors that contribute significantly to under five mortality.

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