Tracking Lesotho's Future Progress towards Achieving Substantial Reduction of Under Five Mortality By 2030

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Abstract - This study uses annual time series data on under five mortality rate for Lesotho from 1960 to 2021 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied model is stable in forecasting U5MR. The ANN (12, 12, 1) projections indicated that U5MR will increase and remain very high throughout the out of sample period. Therefore, we implore the government of Lesotho to focus on channeling more resources to the maternal and child health (MNCH) program to ensure availability of adequate medical supplies and staff at all levels of healthcare.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The Cape Town global action plan (2017) was drafted to strengthen data ecosystems in various countries in line with the sustainable development goals. The main objectives of the global action plan were to ensure that countries improve on coordination of statistical activities and leadership, strengthening basic statistical activities and programs, data dissemination and use, encourage more global partnerships and mobilization of more resources. All UN member countries are encouraged to embrace latest technologies and data sources into main stream statistical activities. The agenda 2030 for sustainable development recognizes the importance of data in review and follow up of sustainable development goals (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). Accurate and reliable data sources are key in getting informed policies and decisions. This study is conducted in line with Vision 2030 for sustainable development, to model and forecast future trends of under-five mortality rate for Lesotho using a machine learning algorithm. The findings will guide child health policies, planning and resource allocation to MNCH program activities to effectively control under five deaths.

II. LITERATURE REVIEW

Baruwa *et al*. (2021) applied duration models (Kaplan Mier and Cox proportional hazards) to examine the relationship between type of birth attendant and neonatal mortality while controlling for socio-demographic characteristics of mothers in Lesotho. The findings of the study revealed that the risk of neonatal mortality is two times higher among children delivered by non-skilled birth attendants. A systematic review carried out by Masaba and Phetoe (2020) found out that in 2018, the neonatal mortality rate for Kenya was 19.6 deaths per 1000 live births. The neonatal mortality rate had fallen gradually from 35.4 deaths per 1000 live births in 1975. On the other hand, South Africa had its neonatal mortality rate fall from 27.9 deaths per 1000 live births in 1975 to 10.7 deaths per 1000 live births in 2018.Nyoni & Nyoni, 2020 applied the Box-Jenkins ARIMA methodology to forecast neonatal deaths in Zimbabwe using annual time series data on neonatal deaths in Zimbabwe from 1966 to 2018.The ARIMA (8, 2, 0) was found to be the optimal model. The study findings revealed that the numbers of neonatal deaths per year would decline sharply over the next 25 years. A similar forecasting study by Nyoni & Nyoni, 2020 utilized the ARIMA model to model and forecast infant mortality in Zimbabwe. The ARIMA (1, 2, 5) was the best model and the forecast results indicated that the number of infant deaths per year, over the out-of-sample period, will follow a downward trend. Kayode *et al*. (2017) examined the variation in neonatal mortality and identified underlying causes of variation in neonatal mortality in sub-Saharan Africa (SSA). The ecological study utilized 2012 publicly available data from WHO, the US Agency for International Development and the World Bank. Variation in neonatal mortality across 49 SSA countries was examined using control chart and explanatory spatial data analysis. Associations between country-level characteristics and neonatal mortality were examined using linear regression analysis. The findings revealed that there was a wide variation in neonatal mortality in SSA. A substantial part of this variation can be explained by differences in the quality of healthcare governance, prevalence of HIV and socioeconomic deprivation.

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 rates for Lesotho.

Data Issues

This study is based on annual total under five mortality rate in Lesotho 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	H
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	0.007530
MSE	0.916584
MAE	0.656682

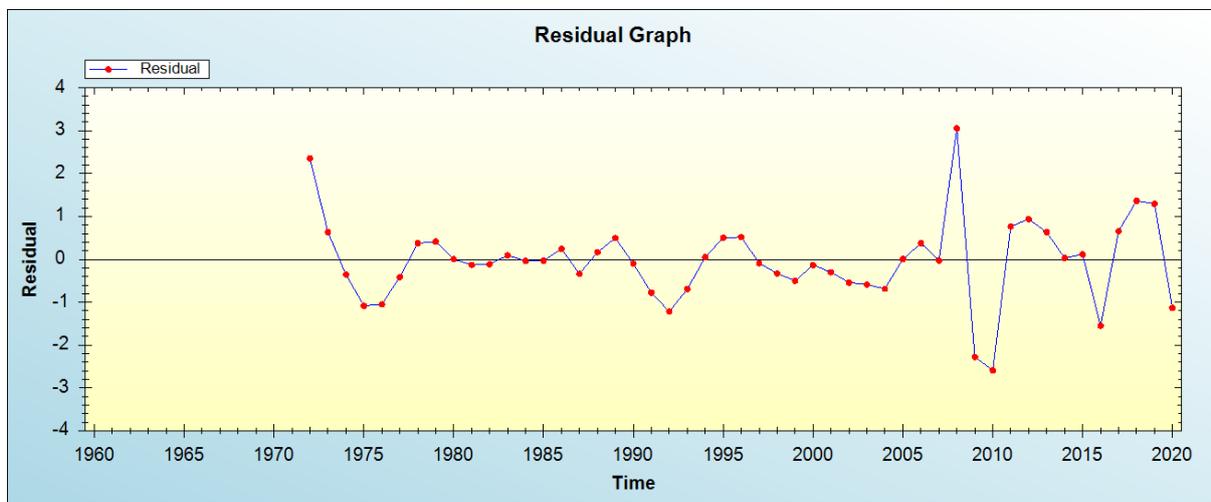Residual Analysis for the Applied Model

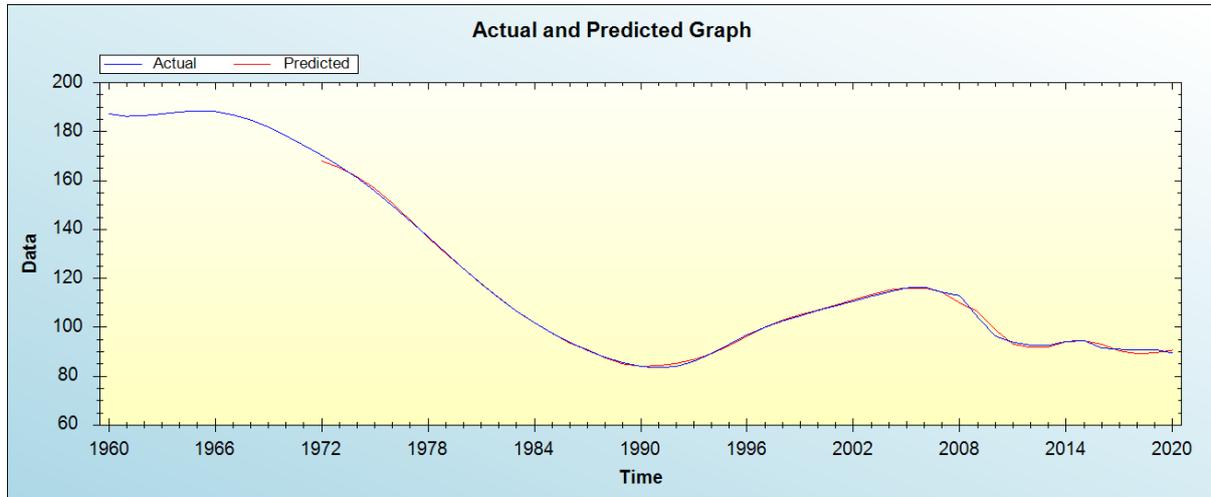Figure 1: Residual analysis

In-sample Forecast for H

Figure 2: In-sample forecast for the H series

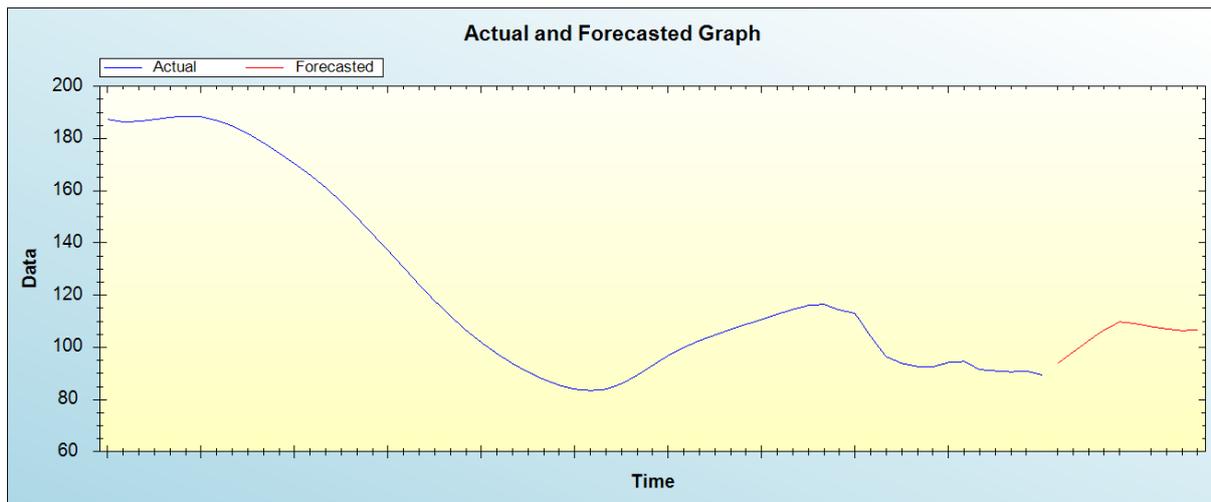Out-of-Sample Forecast for H: Actual and Forecasted Graph

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

Out-of-Sample Forecast for H: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	93.8107
2022	98.1885
2023	102.6085
2024	106.7154
2025	109.7571
2026	109.0980
2027	107.9388
2028	107.0924
2029	106.4214
2030	106.6805

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 increase and remain very high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

High numbers of teenage pregnancies in Lesotho contribute significantly to adverse maternal and child health outcomes. Health education among teenagers can help mitigate these adverse child health outcomes. Under five mortality remains a challenge that requires government action. This study applied the ANN model future trends of U5MR in Lesotho. The findings of this study revealed that U5MR will increase and remain very high throughout the out of sample period. Therefore, we encourage the government of Lesotho to address all the challenges that significantly contribute to under five mortality by allocating more resources to the maternal and child health (MNCH) program.

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