

Projecting Future Trends of Under Five Mortality Rate for St Lucia Using an Artificial Intelligence Technique

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for St Lucia from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied ANN (12, 12, 1) model is stable in forecasting under five mortality rate. ANN model projections revealed that U5MR will hover around 20 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage health authorities in St Lucia to address all the challenges that affect the quality of maternal and child health (MNCH) across the country.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The introduction of sustainable development goals was meant to accelerate efforts to end poverty, hunger, inequalities, injustices, human rights violations, unemployment, global health problems, educational challenges and other deprivations (UN, 2016; UN, 2015). It is important to mention that the successful implementation of the global action plan requires the commitment of political leadership, global partners and the people in various countries. Advocacy and communication will play a pivotal role in information dissemination to all the people and stakeholders so as to achieve maximum collaboration in the implementation process. There is need to continuously strengthen the linkages between different sectors. The Health part of the SDG is linked to other SDGs such as poverty and hunger reduction, education, peace and security, and economic growth. Addressing the major drivers of poverty, hunger, war and climate change will positively impact on population health and on the other hand a healthy population is a determinant of economic development. A healthy population will stimulate economic growth by providing a healthy labor force that is required in the production of goods and services. The scope of the 3rd sustainable development goal is to ensure good health and well-being for all at all the ages. This can be done through universal access to affordable and quality healthcare services leaving no one behind. Provision of quality affordable medicines and vaccines supported by research is key in achieving this goal (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016; UN, 2015).

The objective of this paper is to forecast future trends of under-five mortality rate for St Lucia using artificial neural networks with the aim of ending all preventable under five deaths by 2030.

II. LITERATURE REVIEW

Baruwa *et al.* (2021) applied survival modelling techniques (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. Harpur *et al.* (2021) investigated trends in infant mortality rates (IMR) and stillbirth rates by socio-economic position (SEP) in Scotland, between 2000 and 2018, inclusive. Data for live births, infant deaths, and stillbirths between 2000 and 2018 were obtained from National Records of Scotland. Annual IMR and stillbirth rates were calculated and visualized for all of Scotland and when stratified by SEP. Negative binomial regression models were used to estimate the association between SEP and infant mortality and stillbirth events, and to assess for break points in trends over time. The study revealed that IMR fell from 5.7 to 3.2 deaths per 1000 live births between 2000 and 2018, with no change in trend identified. Stillbirth rates were relatively static between 2000 and 2008 but experienced accelerated reduction from 2009 onwards. When stratified by SEP, inequalities in IMR and stillbirth rates persisted throughout the study and were greatest amongst the subgroup of post-neonates. Nath *et al.* (2020) examined the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. Authors used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistic. Infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life. Logistic regression was applied by Weddih *et al.* (2019) to find the significant predictors of neonatal mortality at the Referral Hospital in Nouakchott, Mauritania. The findings of the study revealed that significant predictors of neonatal mortality were low birth weight, hypothermia, and birth outside the NRH.

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 under five mortality rate for St Lucia.

Data Issues

This study is based on annual under five mortality rate in St Lucia 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	Z
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	0.007614
MSE	2.042144
MAE	1.054180

Residual Analysis for the Applied Model

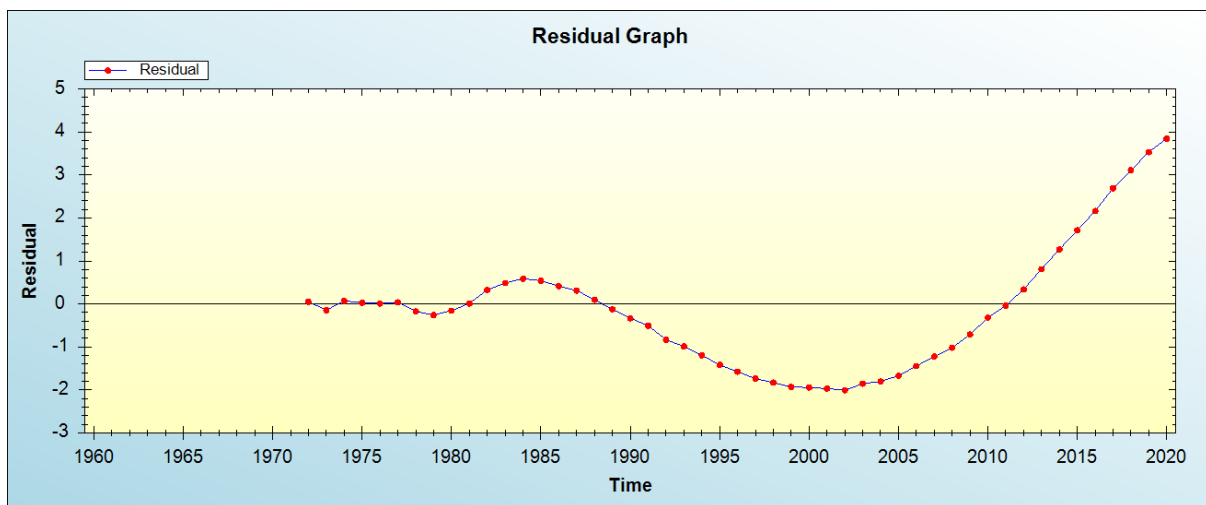


Figure 1: Residual analysis

In-sample Forecast for Z

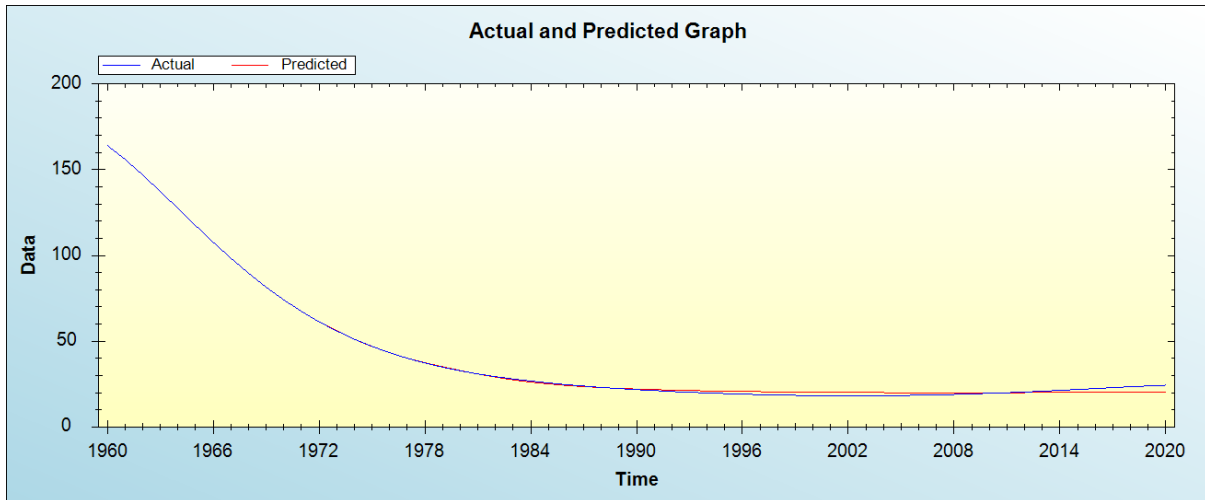


Figure 2: In-sample forecast for the Z series

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

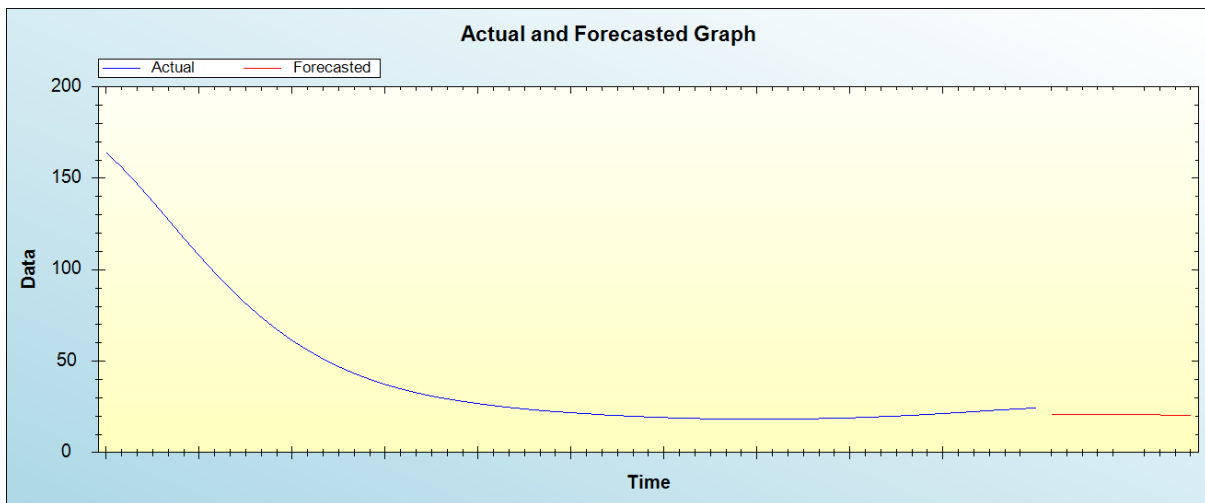


Figure 3: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	20.6514
2022	20.7160
2023	20.7864
2024	20.7179
2025	20.8203
2026	20.6584
2027	20.7686
2028	20.6510
2029	20.5126
2030	20.4533

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 hover around 20 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Forecasting techniques are useful early surveillance tools that guide policies, planning and allocation of resources. This study applied the ANN model to project U5MR in St Lucia and forecast results indicate that U5MR will hover around 20 deaths per 1000 live births throughout the out of sample period. Hence, health authorities in St Lucia are encouraged to address all the challenges that affect the quality of maternal and child healthcare (MNCH) services across the country.

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