Forecasting Under Five Mortality Rate for Solomon Islands Using a Machine Learning Approach

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for Solomon Islands 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 U5MR. ANN model projections indicate that annual U5MR will hover around 20 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Solomon Islands to address all the major challenges that may hinder the success of the maternal and child health program.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Ensuring good health and promotion of well-being for all at all stages of life is one of the key focus areas of sustainable development goals (SDGs) (UN, 2016; UN, 2015). High absolute numbers of maternal, neonatal and under five deaths that define developing countries urgently require new strategies that will be able to effectively address the root causes (UN, 2020; WHO; 2019; UNICEF, 2019). Ensuring that pregnant mothers get quality, affordable, accessible family planning services and essential newborn care is critical in the reduction of maternal and under 5 mortality (WHO, 2019; IOM, 2019; UNFPA, 2018). The targets set by the Lancet commission on investing in Health and the sustainable development goals aim to reduce neonatal and under five mortalityto as low as 12 per 1000 live births and 25 deaths per 1000 live births and global maternal mortality ratio should go below 70 maternal deaths per 100 000 live births by 2030.

In this paper we applied a machine learning technique to forecast future trends of under-five mortality rate for Solomon Islands and the findings are expected to reveal likely future trends of U5MR to inform policy and allocation of resources to maternal and child health program activities in the country.

II. LITERATURE REVIEW

Das & Chakraborty (2021) investigated the influence of both individual and community level factors on neonatal death in Bangladesh. The study utilized data from Bangladesh Demographic and Health Survey 2014. Bivariate analysis was used to examine the differentials in neonatal mortality by selected background variables of both levels.Multilevel logistic model confirmed that there exists clustering impact on neonatal death.An investigation was carried out byZeitlin *et al.* (2020) to find the patterns of stillbirth and neonatal mortality rates in Europe between 2004 and 2010. Data about live births, stillbirths and neonatal deaths by gestational age (GA) were collected using a common protocol by the Euro-Peristat project in 2004 and 2010. The study revealed that stillbirths and neonatal deaths declined at all gestational ages in countries with both high and low levels of mortality in 2004. Wallace *et al.* (2020) investigated infant mortality among native-born children of immigrants in France for the period 2008–17. A nationally representative socio-demographic panel consisting of 296 400 births and 980 infant deaths for the period 2008–17 was used. Children of immigrants were defined as being born to at least one parent born abroad and their infant mortality was compared with that of children born to two parents born in France. Data was analyzed using multilevel logistic regression models and the study results showed that there was a substantial amount of excess infant mortality among those children born to at least one parent from Eastern Europe, Northern Africa, Western Africa, Other Sub-Saharan Africa and the Americas, with variation among specific origin countries belonging to these groups.Another study by Simeoni *et al*. (2019) analyzed the infant (IMR) and neonatal (NMR) mortality rates of Italian and foreign children and evaluated if there is a disparity among geographical macro-areas. Data from 2006 to 2015 were collected by the Italian Statistics Bureau (ISTAT) and extracted from two different national databases, which considered i) underlying cause of death and ii) birth registry. The main analyses were made comparing Italian versus foreigners as a single category as well as by country origin and contrasting Northern residents versus Southern ones. Comparisons between groups were done using relative risks. The study findings revealed that Inequalities in neonatal and infant mortality are evident between Italians and immigrants and among geographical macro-areas.

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 in Solomon Islands.

Data Issues

This study is based on annual under five mortality rate in Solomon Islands 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	Y
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	0.008330
MSE	2.136048
MAE	1.087736

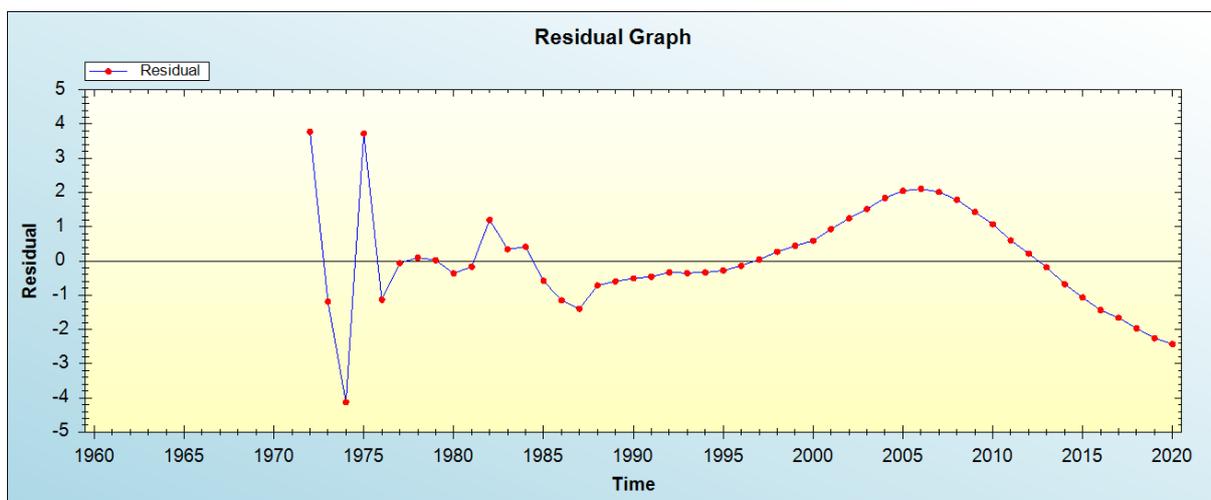Residual Analysis for the Applied Model

Figure 1: Residual analysis
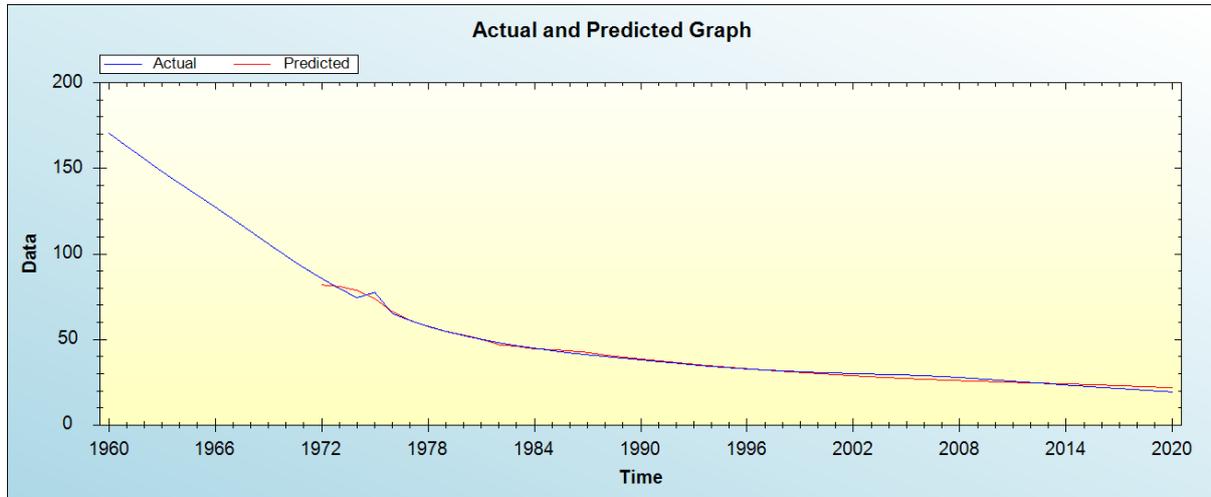
In-sample Forecast for Y

Figure 2: In-sample forecast for the Y series

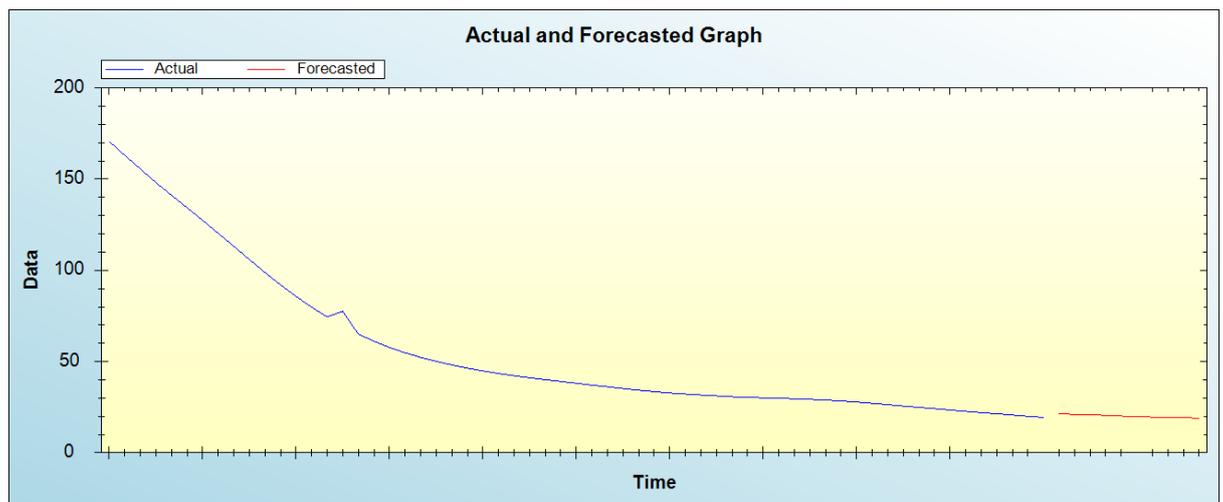Out-of-Sample Forecast for Y: Actual and Forecasted Graph

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

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	21.3689
2022	20.9783
2023	20.7628
2024	20.5905
2025	20.1412
2026	19.7584
2027	19.5773
2028	19.4225
2029	19.2941
2030	18.9901

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

Under five mortality remains a global health challenge especially in developing countries. Most of the deaths are preventable therefore efforts to identify the leading causes should be made in order address this problem. Socio-cultural, demographic and health system related factors contribute significantly to under five mortality. The ANN model was applied in this study to project future trends of under-five mortality rate in Solomon Islands and forecast results showed thatannual U5MR will hover around 20 deaths per 1000 live births throughout the out of sample period. Therefore, authorities in Solomon Islands must address all the challenges that may hinder the success of the maternal and child health program in the country.

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