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Tracking Madagascar's 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 Madagascar 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 model is stable in forecasting U5MR in Madagascar. The ANN (12, 12, 1) projections indicate that U5MR will remain high throughout the out of sample period. Hence, we implore health authorities in Madagascar to allocate more resources to the maternal and child health (MNCH) program to ensure availability of medical supplies and medical staff at all levels of healthcare especially in the rural areas.**

Keywords: ANN, Forecasting, U5MR

I. INTRODUCTION

The global sustainable development goals (SDGs) came into existence due to the failure of millennium development goals (MDGs) to address all the problems affecting people around the globe (UN, 2016; UN, 2015). SDGs clearly outline the urgent need for all 193 UN member states to eradicate poverty, hunger and other forms of deprivation (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018).Developing countries are lagging behind in addressing the major global issues highlighted in the 2030 Agenda for sustainable development (UN, 2020; WHO, 2019; UNICEF, 2019).Madagascar is a Sub-Saharan country in the SADC region with a poverty rate of 70.5% (UN, 2020). Access to health is still a challenge in this country. The majority of primary health care facilities are not easily accessible with 25.8% of the population living approximately 10km away from medical facilities (Madagascar, 2018). Persistent stock out of essential medical supplies is affecting the quality of health services being offered in healthcare centres (Lang *et al*. 2018; Mattern, 2017; Morris *et al.* 2014). In line with the Agenda 2030, this research is carried out to forecast future trends of under-five mortality rate in Madagascar using the artificial neural network approach. We expect the findings to inform child health policies, decisions, planning and allocation of resources with the aim of substantially reducing under five mortality to as low as 25 deaths per 1000 live births by 2030.

II. LITERATURE REVIEW

Schellekens (2021) estimated the contribution of maternal education to infant mortality decline in Indonesia. A longitudinal, individual-level analysis of the determinants of trends in infant mortality in Indonesia was done by utilizing pooled data from all available phases of the Demographic and Health Survey (1980-2015).The study findings revealed that maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015. Andrianantoandro *et al.* (2021) carried out a method methods study in Madagascar to identify and analyze the factors that influence the utilization of maternal services, specifically, the use of antenatal care (ANC) during pregnancy and the use of skilled birth attendants (SBAs) at delivery. . Data was collected for the period October 2016 to July 2017. A total of 245 pregnant women were included and followed up in the quantitative survey, and among them, 35 participated in in-depth interviews (IDIs). Logistic regression was applied to explore the influencing factors of antenatal and delivery healthcare seeking practices through thematic qualitative analysis. The study results showed that school level; the frequency of ANCs; the origin region; and the preference between modern or traditional care influenced the use of SBAs at delivery.Masaba & Phetoe (2020) described the trends of neonatal mortality within the two sub-Saharan countries. The study concluded 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.Bitew *et al*. (2020) determined the incidence density rate and predictors of neonatal mortality by utilizing electronic databases. The study findings indicated thatthe incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors.

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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 Madagascar.

Data Issues

This study is based on annual under five mortality rate in Madagascar for the period 1968– 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	G
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	0.002228
MSE	0.506615
MAE	0.521751

Residual Analysis for the Applied Model

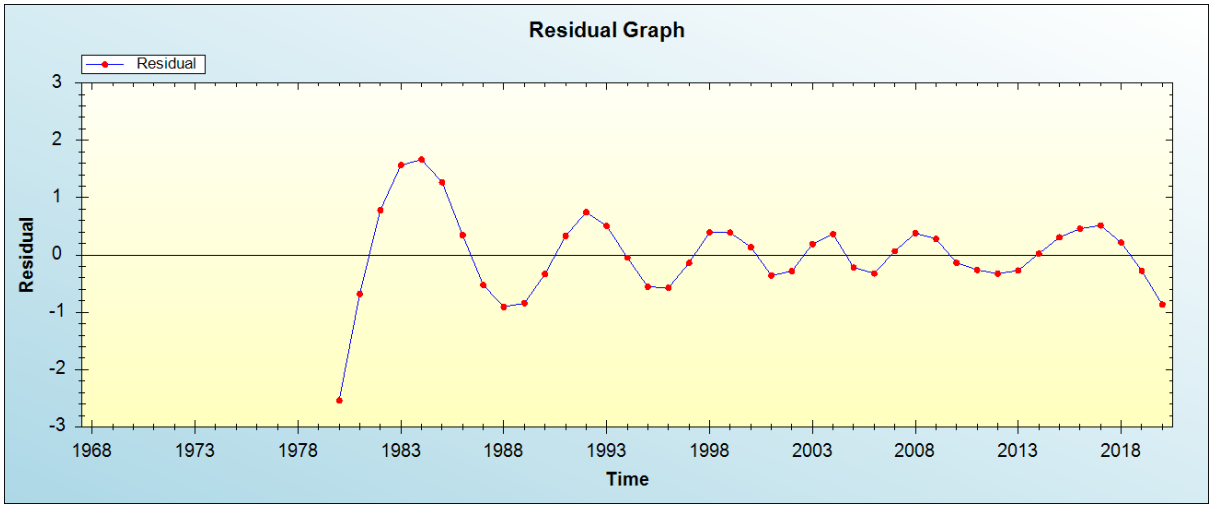

Figure 1: Residual analysis

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In-sample Forecast for G

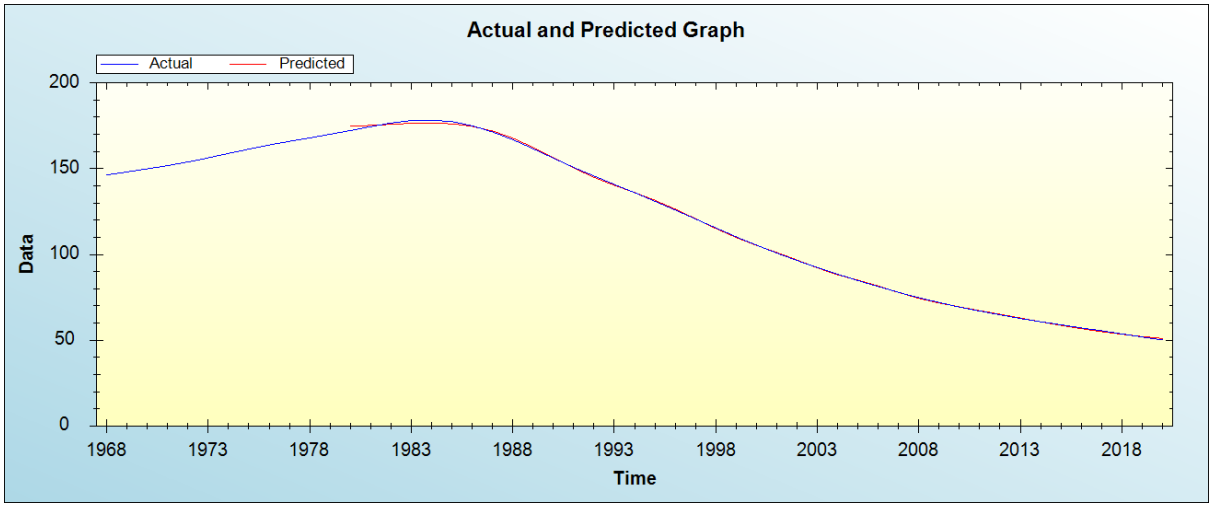

Figure 2: In-sample forecast for the G series

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

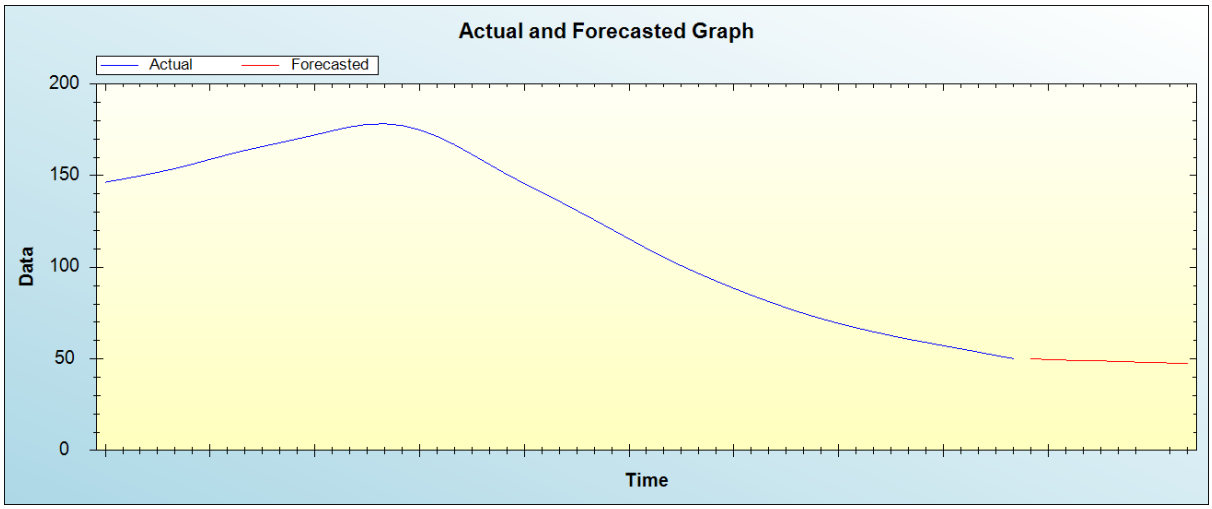

Figure 3: Out-of-sample forecast for G: actual and forecasted graph

Out-of-Sample Forecast for G: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	50.1507
2022	49.6149
2023	49.3233
2024	49.1264
2025	48.9367
2026	48.6370
2027	48.3121
2028	48.0287
2029	47.7670
2030	47.6707

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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 throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Madagascar is facing numerous challenges that affect the quality of healthcare services such as shortage of medical staff and medical supplies, and long distances travelled to healthcare facilities. Drought induced by climate change has driven millions of people into hunger and extreme poverty. This study applied the ANN model to project future trends of under-five mortality rate and forecast results have revealed that U5MR will remain high throughout the out of sample period. Therefore, we encourage the government of Madagascar to allocate more resources to the maternal and child health (MNCH) program to ensure availability of medical supplies and medical staff at every healthcare facility especially in the rural areas.

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