

# Tracking South Sudan's Progress Towards Achieving Substantial Reduction of Under Five Mortality by 2030 Using a Machine Learning Method

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**Abstract - This study uses annual time series data on under five mortality rate (U5MR) for South Sudan from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicates that the applied ANN (12, 12, 1) model is stable in forecasting U5MR. ANN model projections suggest that annual U5MR will remain very high throughout the out of sample period. Therefore, we encourage the South Sudanese government to channel more resources to the maternal and child health program to ensure availability of medical supplies, equipment and healthcare professionals.**

**Keywords:** ANN, Forecasting, U5MR.

## I. INTRODUCTION

The devastating effects of wars and civil conflicts has negatively affected many countries and their persistence will almost erase the prospects of achieving set targets for sustainable development goals (SDGs) by 2030. It is worrying to see women and children suffering in conflict zones. In addition, it is retrogressive to witness the destruction of health infrastructure and other important facilities which are key in the implementation of sustainable development goals (SDGs). Ending preventable deaths of pregnant women and under five children is difficult in conflict affected zones. The agenda 2030 for sustainable development recognizes the importance of crafting strategies to end wars and conflict, and encourage peaceful dialogue to end disagreements with respect of international law and justice (UN, 2016; UN, 2015). Despite these difficult circumstances, there is an expectation that all UN member countries should strive to achieve their SDG targets by 2030 in the best interest of their people. Top on the list of global health concerns is the need to end all preventable maternal, newborn and under five deaths under the 3<sup>rd</sup> sustainable development goal (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). In line with the agenda 2030 for sustainable development, this research applies the artificial neural network approach to project future trends of under-five mortality rate for South Sudan with the aim of ending all preventable under five deaths through the implementation of effective strategies.

## II. LITERATURE REVIEW

Boettiger *et al.* (2021) described household factors associated with under-five mortality in Bankass, a remote region in central Mali. The authors analyzed baseline household survey data from a trial being conducted in Bankass. The survey was administered to households between December 2016 and January 2017. Under-five deaths in the five years prior to baseline were documented along with detailed information on household factors and women's birth histories. Factors associated with under-five mortality were analyzed using Cox regression. The study revealed that U5 mortality is very high in Bankass and is associated with living a greater distance from healthcare and several other household factors that may be amenable to intervention or facilitate program targeting. A matched case-control study using verbal social autopsy was conducted by Gupta *et al.* (2018) to investigate the causes and predictors of childhood mortality in Rwanda. Authors utilized conditional logistic regression to identify clinical, family, and household risk factors for death. It was found out that there was a large proportion of remaining deaths occur at home, with home deliveries still representing a significant risk factor for neonatal death. The major causes of death at a population level remain largely avoidable communicable diseases. Brault *et al.* (2018) investigated factors contributing to the reductions in under-five mortality in Postwar Liberia by conducting a case study mixed methods approach drawing on data from quantitative indicators, national documents and qualitative interviews were used to describe factors that enabled Liberia to rebuild their maternal, neonatal and child health (MNCH) programmes and reduce under-five mortality following the country's civil war. The findings revealed that three main factors contributed to the reduction in under-five mortality: national prioritization of MNCH after the civil war; implementation of integrated packages of services that expanded access to key interventions and promoted inter-sectoral collaborations; and use of outreach campaigns, community health workers and trained traditional midwives to expand access to care and improve referrals. A cross-sectional study carried out by Edem *et al.* (2020) examined the health practices, care-seeking behavior, and referral of sick out-born neonates to a district and regional hospital in the Upper West

Region of Ghana. The study findings suggested that socio-cultural factors strongly influence health seeking behavior and the health outcome of neonates in this setting.

### 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 South Sudan.

#### Data Issues

This study is based on annual under five mortality rate in South Sudan 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	
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	0.000562
MSE	0.444422
MAE	0.496121

#### Residual Analysis for the Applied Model

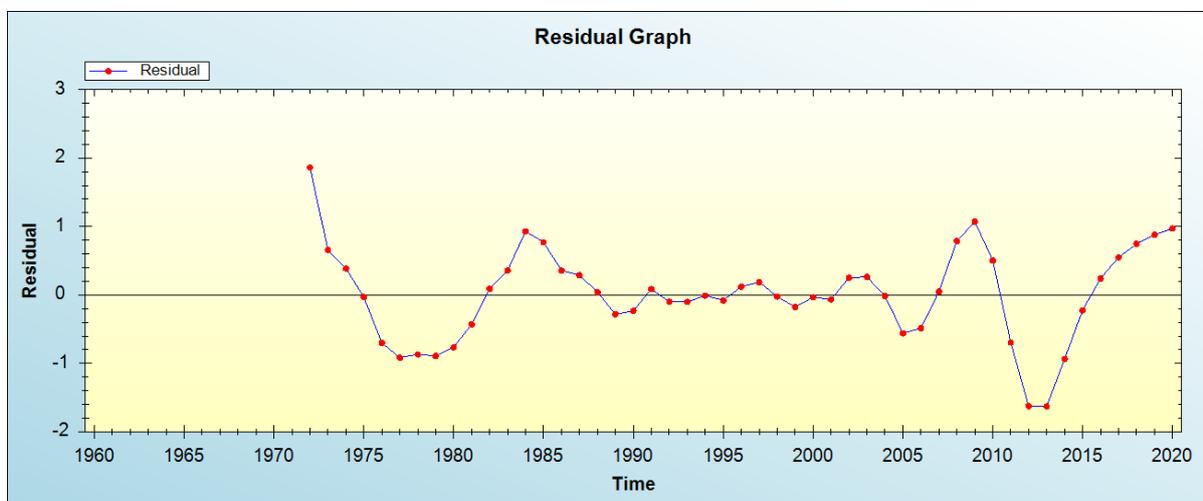


Figure 1: Residual analysis

In-sample Forecast for C

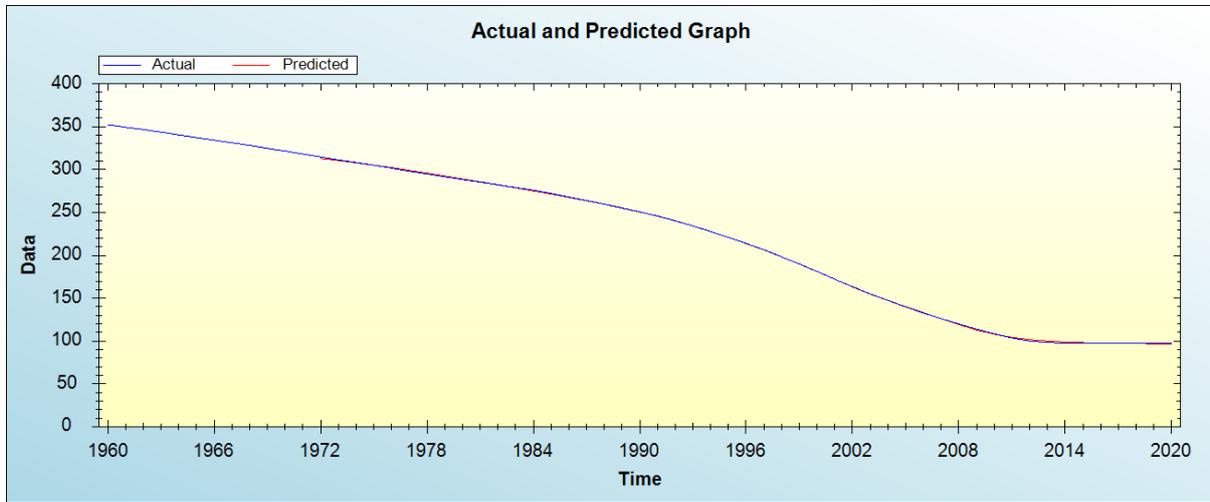


Figure 2: In-sample forecast for the C series

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

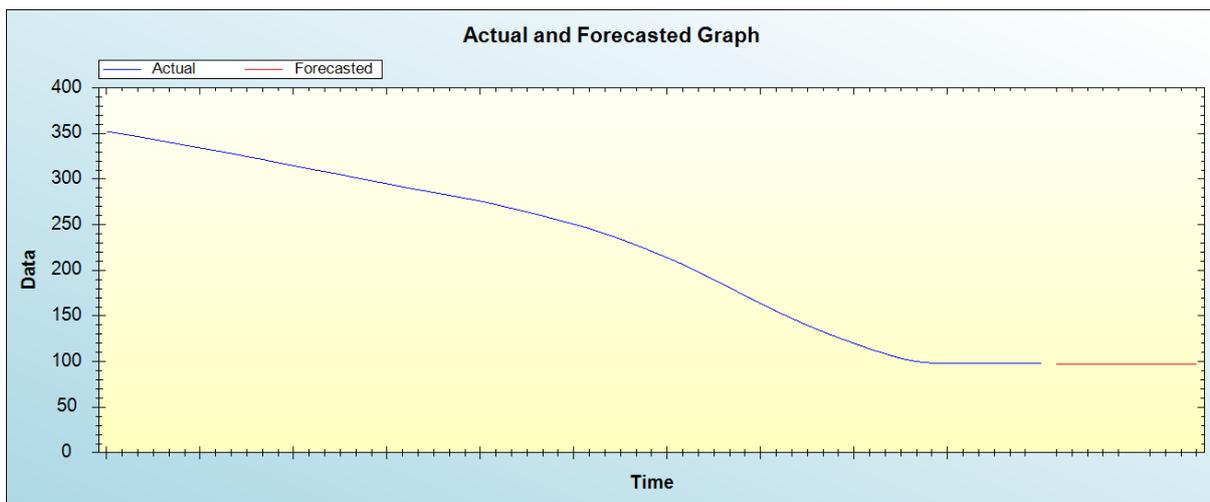


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	96.8657
2022	96.8207
2023	96.7944
2024	96.7806
2025	96.7744
2026	96.7720
2027	96.7710
2028	96.7686
2029	96.7683
2030	96.7671

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 very high throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

Despite numerous challenges being faced by the government of South Sudan, the country has demonstrated its commitment to the agenda 2030 for sustainable development as shown by the gradual decline in under five and neonatal mortality rates over the past decades. However existing challenges need urgent attention in order to achieve the set target under SDG3 target 3.2. This study applied the ANN model to forecast future trends of under-five mortality rate in South Sudan and findings revealed that annual U5MR will remain very high throughout the out of sample period. Hence, the government should allocate more resources to the maternal and child health program to ensure availability of medical supplies, equipment and healthcare professionals.

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