

# Forecasting Total Fertility Rate in Malawi

<sup>1</sup>Dr. Smartson. P. NYONI, <sup>2</sup>Tatenda. A. CHIHOHO, <sup>3</sup>Thabani NYONI

<sup>1</sup>ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

<sup>2</sup>Independent Health Economist, Zimbabwe

<sup>3</sup>SAGIT Innovation Center, Harare, Zimbabwe

**Abstract - In this research paper, the ANN approach was applied to analyze TFR in Malawi. The employed data annual covers the period 1960-2018 and the out-of-sample period ranges over the period 2019-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting TFR in Malawi. The results of the study indicate that annual total fertility rates in Malawi are likely to be around 4.3 births per woman over the out-of-sample period. Therefore, the Malawian government is encouraged to increase public awareness of family planning programs in order to reduce adverse sexual and reproductive health (SRH) outcomes, prioritize women empowerment.**

**Keywords:** ANN, Forecasting, Total fertility rate (TFR).

## I. INTRODUCTION

The sub-Saharan African region has made significant progress in maternal and child health services, however total fertility rate (TFR), unintended pregnancies and unwanted births remain high (Karra et al, 2016). The increased access to family planning services has significantly improved children's growth and development as this allows families to better space their children thereby reducing the incidence of protein energy malnutrition cases.

The essential components of a family planning program are 1) demand creation and advocacy 2) service delivery 3) monitoring and evaluation 4) support and supervision 5) logistics and finance and 6) quality assurance. Demand creation is an important part of family planning because it is a tool to inform the public about the available family planning services. Adolescents in developing countries lack access to comprehensive knowledge on family planning and STIs (Kaphagawani& Kalipeni, 2017; Karra et al, 2016).

Total fertility rate in Malawi has been declining over the years from 6.9 births per woman in 1955 to 4.3 births per woman in 2020. The recorded an infant mortality rate of 32.6 infant deaths per 1000 live births and under five mortality rate of 43.7 deaths per 1000 live births in 2020 (Worldometer, 2020). Malawi has high adolescent fertility rates due to several factors which include lack of comprehensive sexual and reproductive health knowledge, gender inequality and cultural practices which promote child marriage (Kaphagawani et al, 2017). Machira et al (2020) examined the determinants of risky sexual behavioral practices among teen women in Malawi. The study found the existence of differential determinants to influence women's conduct in having both multiple sexual partners and inability to use condom during subsequent sexual intercourses with partners other than spouses. A secondary analysis of the Global School-based Student Health Surveys (GSHS) datasets pooled from five SSA countries Benin, Mozambique, Namibia, Seychelles, and Tanzania were done by Shayo and Kalomo (2019). Logistic regression was applied and the results indicated that Adolescents sexual intercourse and more especially sex with multiple partners was prevalent and strongly correlated with substance use. Yakubu et al (2018) did a systematic review to identify factors influencing adolescent pregnancies in sub-Saharan Africa in order to design appropriate intervention program. A search in MEDLINE, Scopus, Web of science, and Google Scholar databases with the following keywords: determinants, factors, reasons, socio cultural factors, adolescent pregnancy, unintended pregnancies, and sub-Saharan Africa. The study concluded that high levels of adolescent pregnancies in Sub-Saharan Africa is attributable to multiple factors which included socio cultural and economic, individual, and health service related factors.

The aim of this study is to forecast TFR in Malawi using an artificial intelligence technique. The results of the study are expected to reveal the likely future trends in TFR in the country to facilitate resource allocation for health, education and employment creation.

## II. 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 total fertility rates in Malawi.

**Data Issues**

This study is based on annual total fertility rate (births per woman) in Malawi for the period 1960 – 2018. The out-of-sample forecast covers the period 2019 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

**III. FINDINGS OF THE STUDY**

**ANN Model Summary**

Table 1: ANN model summary

Variable	M
Observations	47 (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	0.077743
MSE	0.020315
MAE	0.116340

*Residual Analysis for the Applied Model*

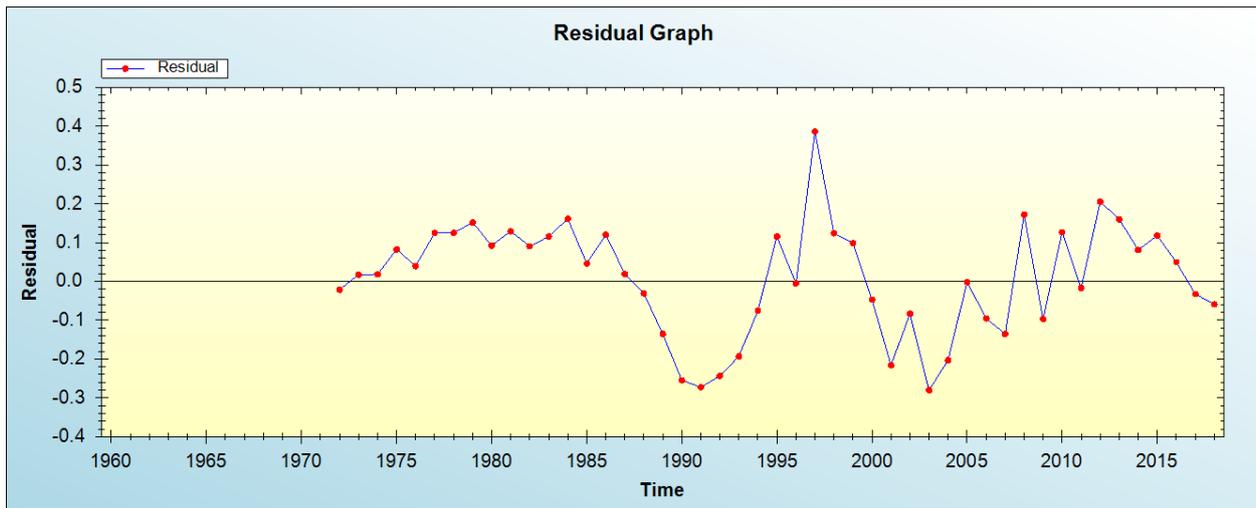


Figure 1: Residual analysis

*In-sample Forecast for M*

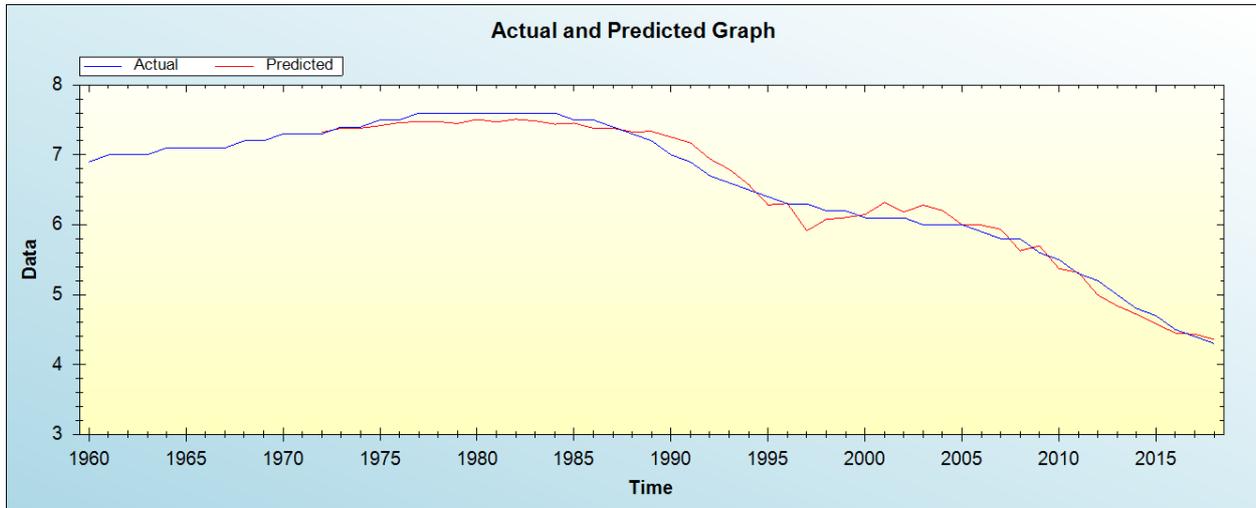


Figure 2: In-sample forecast for the M series

*Out-of-Sample Forecast for M: Actual and Forecasted Graph*

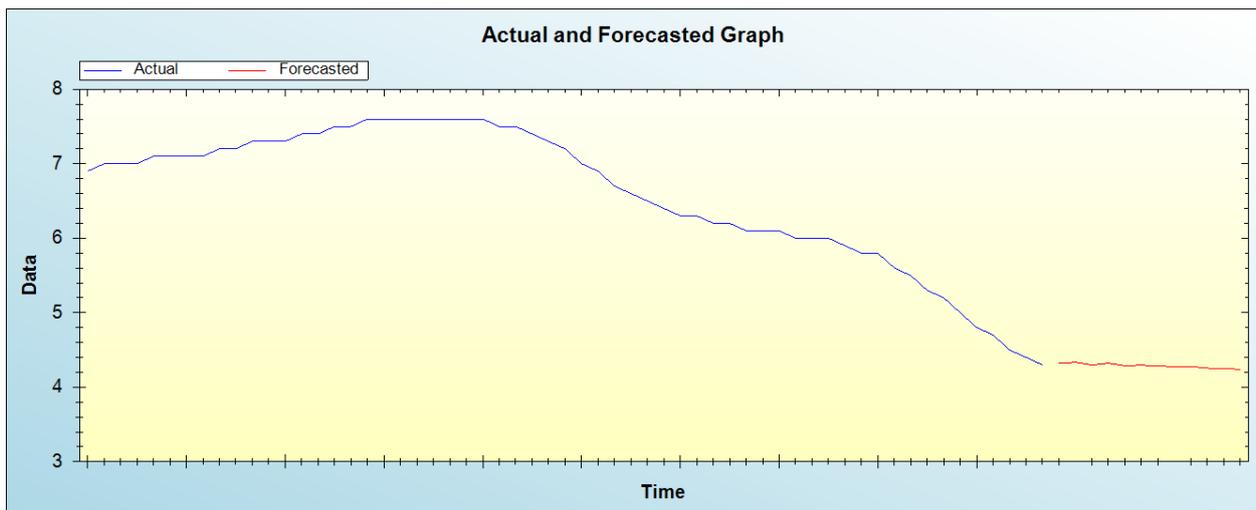


Figure 3: Out-of-sample forecast for M: actual and forecasted graph

*Out-of-Sample Forecast for M: Forecasts only*

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	4.3202
2020	4.3348
2021	4.2983
2022	4.3224
2023	4.2900
2024	4.2948
2025	4.2907
2026	4.2719
2027	4.2796
2028	4.2563
2029	4.2526
2030	4.2395

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 total fertility rates in Malawi are likely to be around 4.3 births per woman over the out-of-sample period.

#### IV. CONCLUSION & RECOMMENDATIONS

Malawi's total fertility rate declined over the years; however the country has a lot of work to do to reduce teenage pregnancies and child marriages. In this study we proposed a machine learning algorithm to project TFR in Malawi. The neural network model projections suggest that annual total fertility rates in Malawi are likely to be around 4.3 births per woman over the out-of-sample period. Therefore, the Malawian government is encouraged to increase public awareness of family planning programs in order to reduce adverse sexual and reproductive health (SRH) outcomes, and prioritize women empowerment programs.

#### REFERENCES

- [1] Mahesh Karra, David Canning, Daniel Maggio (2016). The Impact of Family Planning on Fertility, Birth Spacing, and Child Development in Urban Malawi, pp 1-4.
- [2] Kaphagawani NC & Kalipeni E (2017). Sociocultural factors contributing to teenage pregnancy in Zomba District, Malawi. *Glob Public Health*, 12(6):694– 710. <https://doi.org/10.1080/17441692.2016.1229354>
- [3] Worldometer (2020). Malawi demographics. <https://www.worldometers.info>

#### Citation of this Article:

Dr. Smartson. P. NYONI, Tatenda. A. CHIHOHO, Thabani NYONI, "Forecasting Total Fertility Rate in Malawi" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 8, pp 236-239, August 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.508050>

\*\*\*\*\*