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Projection of Total Fertility Rate (TFR) in the Democratic Republic of Congo

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***Abstract* - In this research article, the ANN approach was applied to analyze TFR in the DR Congo. The employed annual data 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 the DR Congo. The results of the study indicate that annual total fertility rates in DRC are likely to slightly rise over the out-of-sample period. Therefore, the authorities in DRC are encouraged to (1) focus on addressing adolescent and young adult challenges in accessing family planning services and create more demand for sexual and reproductive (SRH) services through mass media and other local platforms, and (2) engage on a women empowerment drive to increase their labor participation and contribution to economic development.**

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

I. INTRODUCTION

The Democratic Republic of Congo (DRC) has an estimated population size of 79,9 million and its total fertility rate of 6.5 births per woman is the third highest in the world ranging from 5.4 births per woman (Urban) to 7.3 births per woman (Rural) (MSP/Congo, 2014). It is among the poorest countries of the world ranking 178 out of 188 for human development index (UNDP, 2016). Approximately 52% of the population is below 15 years (MSP, 2014). High teenage or adolescent pregnancies contribute significantly to the high fertility levels (MSP, 2014). In 2019, the modern contraceptive prevalence rate among married women or in union was 11.2 %, the unmet need for family planning among married women was 40.6 % and the number maternal deaths averted by use of contraception was 34 000 (DRC FP 2020).

According to Worldometer, the total fertility rate in DRC increased from 6.0 births per woman in 1955 to 6.8 in the year 2000. Over the period 2000-2020, the country witnessed a fertility transition from 6.8 births per woman to 6.0 births per woman, however fertility rates remain high. Furthermore the country has recorded a downward trend in infant and under 5 mortality rates. IMR declined from 166.33 infant deaths per 1000 live births in 1950 to 59.68 infant deaths per 1000 live births in 2020. Under five mortality dropped from 280.52 deaths per 1000 live births in 1950 to 91.23 deaths per 1000 live births in 2020 (Worldometer, 2020). There are few published studies in the country and region which have focused on investigating fertility trends. In this study we shall mention relevant papers. Based on a cross-sectional study, Apanga et al (2020) assessed the prevalence and factors associated with modern contraceptive (CP) use among women of the reproductive age. The authors used data from the Multiple Indicator Cluster Surveys (MICSs) from 20 African countries collected between 2013 and 2018.Employed Data on 1 177 459 women aged 15–49 years old and Multivariable logistic regression was used to identify factors associated with modern CP use. The study revealed that the overall prevalence of modern CP use was 26% and ranged from 6% in Guinea to 62% in Zimbabwe. Women were more likely to use a modern CP if they: had a primary or secondary/higher education compared with women with no formal education; had no delivery in the last 2 years compared with women who delivered in the last 2 years. A similar study was done by Casey et al (2019) who found out that modern contraceptive prevalence among women in union ranged from 8.4% to 26.7% in the six health zones; current use of long-acting or permanent method (LAPM) ranged from 2.5% to 19.8%. Mbadu Muanda et al (2018) examined adolescents' and young people's insights on their cultural norms, practices and attitudes towards SRH services. Fourteen focus group discussions were conducted with a total of 224 adolescents and young people aged 15–24 years in urban and rural areas of the DRC. The topics discussed and age groups of participants differed somewhat in the urban and rural areas. Data were analyzed to identify themes in the participants' discussion of their attitudes towards SRH. The study revealed that there is pressing need for information and services for young people in both urban and rural areas.

The aim of this study is to project total fertility rate in DRC using a machine learning technique. The findings of this paper are envisioned to provide an insight of the likely fertility trends in the out of sample period. This will guide policy and planning, and stimulate an appropriate timeouts response to the likely future health, education and employment needs of the people in the DRC.

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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 Democratic Republic of Congo (DRC).

Data Issues

This study is based on annual total fertility rate (births per woman)in DRC 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	D
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	0.151536
MSE	0.005154
MAE	0.058611

Residual Analysis for the Applied Model

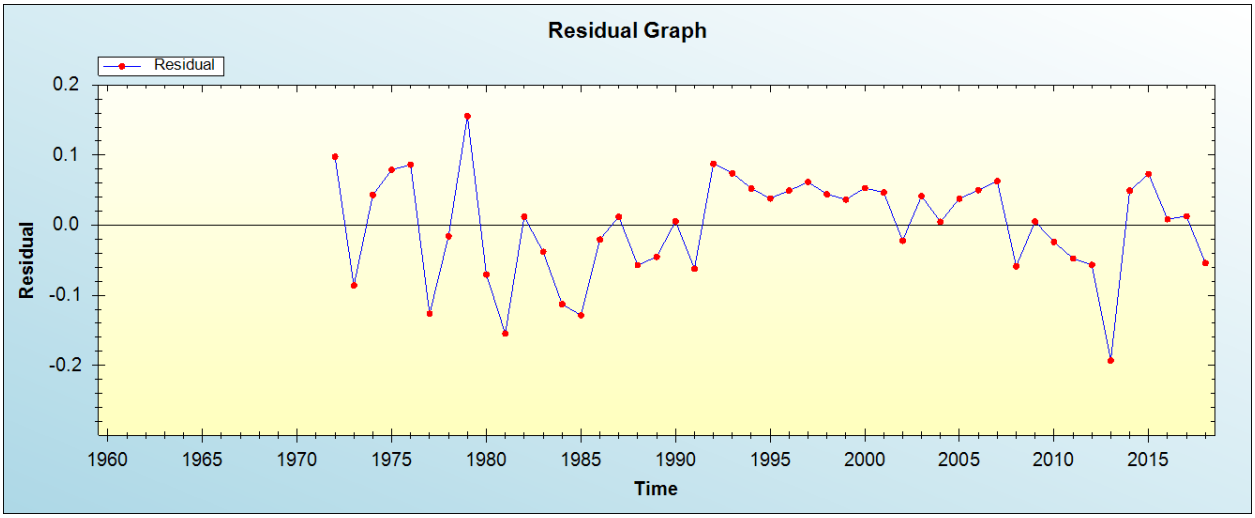

Figure 1: Residual analysis

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In-sample Forecast for D

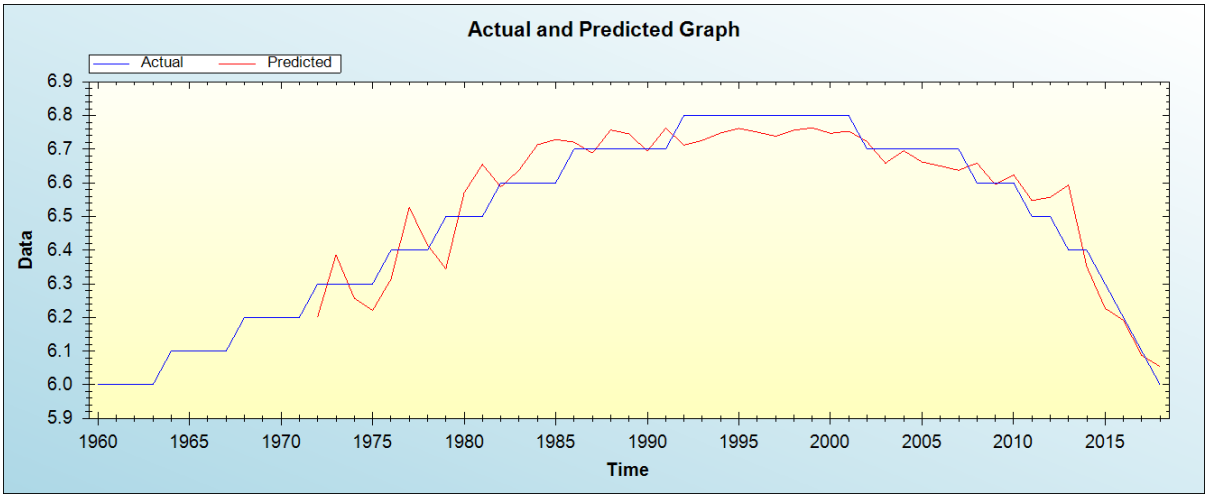

Figure 2: In-sample forecast for the D series

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

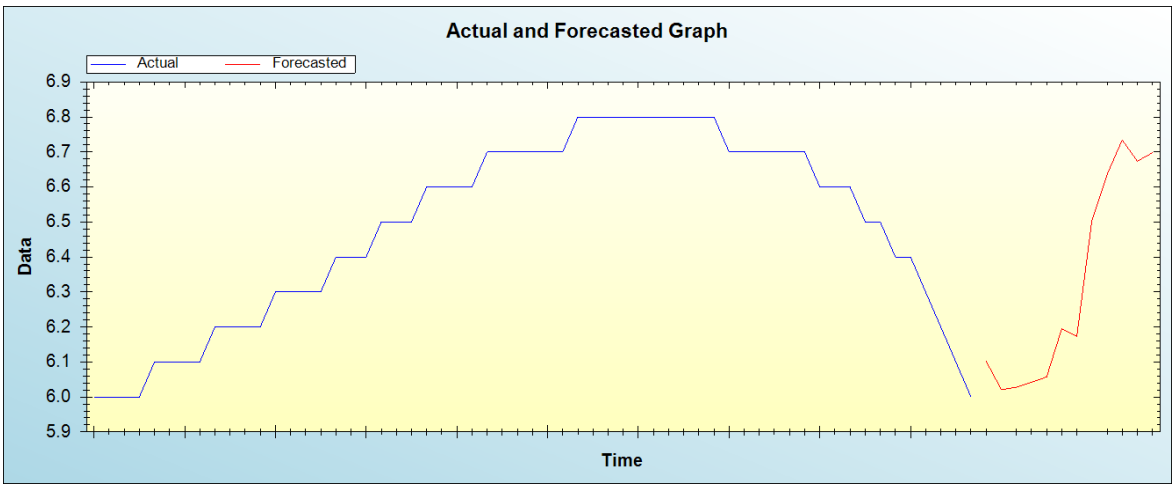

Figure 3: Out-of-sample forecast for D: actual and forecasted graph

Out-of-Sample Forecast for D: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Forecasts
2019	6.1022
2020	6.0212
2021	6.0276
2022	6.0420
2023	6.0572
2024	6.1945
2025	6.1730
2026	6.5062
2027	6.6354
2028	6.7345
2029	6.6734
2030	6.6979

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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 total fertility rates in DRC are likely to slightly rise over the out-of-sample period.

IV. CONCLUSION & RECOMMENDATIONS

The Democratic Republic of Congo is characterized by high teenage pregnancies, low contraceptive prevalence and high unmet need for family planning hence the country continues to report high maternal and infant mortality. In this article we applied a machine learning algorithm to project total fertility rate in DRC and the ANN model projections revealed that annual total fertility rates in DRC are likely to slightly rise over the out-of-sample period. Therefore, the DRC government must focus on addressing adolescent and young adult challenges in accessing family planning services and create more demand for sexual and reproductive health (SRH) services through mass media and other local platforms. Women's participation in labor is critical for economic development.

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