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Tracking Future Trends of Under Five Mortality in Tunisia Using an Artificial Intelligence Method

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Tunisia from 1962 to 2020to 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 under five mortality rate. ANN model forecast results indicate thatU5MR will hover around 16 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Tunisian government to address all the challenges that affect the successful implementation of the 3rd sustainable development goal (SDG3) in order to keep under-five mortality under control.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Ending all forms of deprivation by 2030 is the main objective of the global sustainable development goals. Low and middle income countries are persistently stuck in poverty, hunger, drought, civil conflict and economic turmoil. The role of all UN member states is to encourage technological advancement in all sectors of the economy so as to improve on food security through advancement in irrigation systems and sustainable farming practices. Technological improvements in the health sector are expected to improve the quality and quantity of healthcare services (UN, 2020; WHO, 2019; UNICEF, 2019). Sub-Saharan Africa and South Asia are known for reporting numerous challenges which range from poverty, hunger, high numbers of maternal and under five mortality and high teenage pregnancies (Thomson & Tevar, 2020; Kayode *et al.* 2017;Child mortality report, 2017;WHO, 2017; WHO, 2016). These perennial problems require all stakeholders to speak with one voice, mobilize adequate resources and quickly attend to the issues to alleviate suffering among the people. Ensuring good health and promotion of well-being for all at all ages is the focus of the 3rd sustainable development goal. To achieve this ambitious goal it is important for all UN member countries to channel resources to the health sector and other health related sectors (UNICEF; 2018; UN, 2016; UN, 2015). There is need to train adequate medical staff and retain them through attractive salaries, incentives and other benefits. Governments should prioritize improving health infrastructure especially that of primary health care which is often dilapidated in many developing countries. SDG 3 target 3.1 aims to ensure a decline in maternal mortality ratio to below 70 deaths per 100 000 live births by 2030. SDG 3 target 3.2 deals with bringing down neonatal and under five mortality to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births respectively by 2030 (UNICEF, 2019). The objective of this paper is to predict future trends of under-five mortality for Tunisia using a machine learning algorithm. We expect the results of this research to inform maternal and child (MNCH) policy making and allocation of resources to maternal and child health program activities so as to effectively control deaths among under five children.

II. LITERATURE REVIEW

Lahmini and Bourrous (2020) carried out a retrospective and descriptive study, over five years (1st January 2012 and 31st December 2016) including all children aged from 0 to 15 years old who died at the PED in the Mohamed VI Hospital in Marrakech. The aimed of the study was to examine pediatric mortality Makarrakech pediatric emergency department. It was found out that the most common causes of pediatric mortality were neonatal pathologies (62.3%), infections (7.7%), birth deformities (7.3%), and trauma (0.9%). Neonatal mortality was mainly due to infections (32.2%) and prematurity (24.4%). A study conducted in Zimbabwe by Nyoni & Nyoni (2020) analyzed monthly time series data on neonatal death cases at Chitungwiza Central Hospital (CCH) from January 2013 to December 2018 using Box-Jenkins SARIMA models and found out that there will be a slow but steady decrease in neonatal deaths at CCH over the out-of-sample period.An investigation of factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania was carried out by Weddih *etal.* (2019). A cross-sectional study was conducted between January 2013 and December 2013 and included neonatal patients hospitalized at the National Referral Hospital (NRH). Data were collected by reviewing the medical charts and through questionnaires administered to the parents. The findings of the study indicated that significant predictors of neonatal mortality were low birth weight, hypothermia and birth outside NRH.In a 2018 descriptive study, Merabet *et al* described neonatal deaths and identified their risk factors at the Al Hoceima Provincial Hospital. The study findings revealed that neonatal mortality in the Al Hoceima hospital remains high and is mainly related to the course of pregnancy and childbirth as well as the characteristics of the newborn at birth.

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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 Tunisia.

Data Issues

This study is based on annual under five mortality rate in Tunisia for the period 1962 – 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	N
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	0.000924
MSE	0.701972
MAE	0.690255

Residual Analysis for the Applied Model

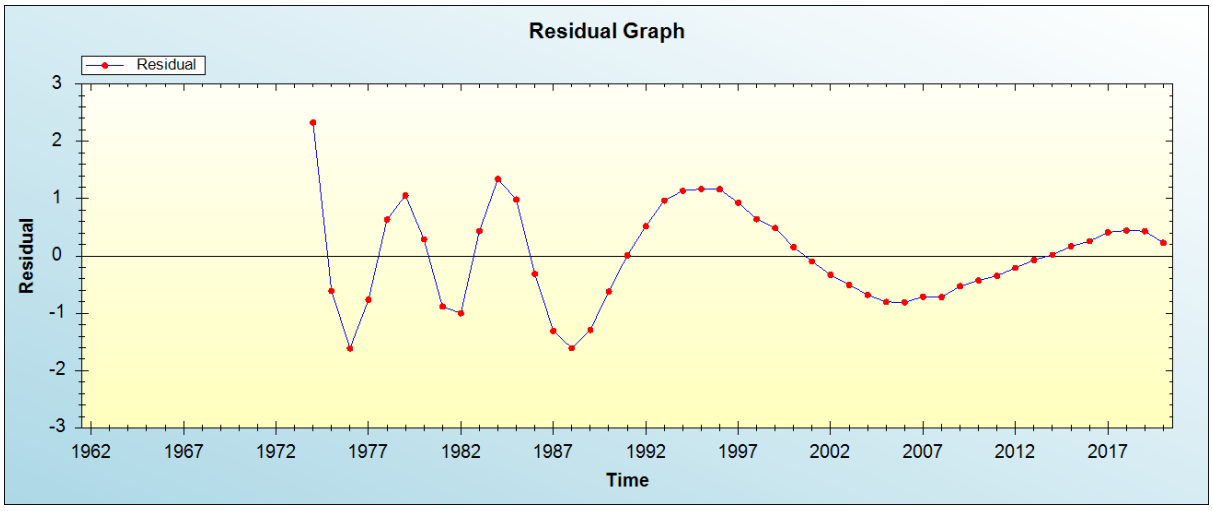

Figure 1: Residual analysis

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In-sample Forecast for N

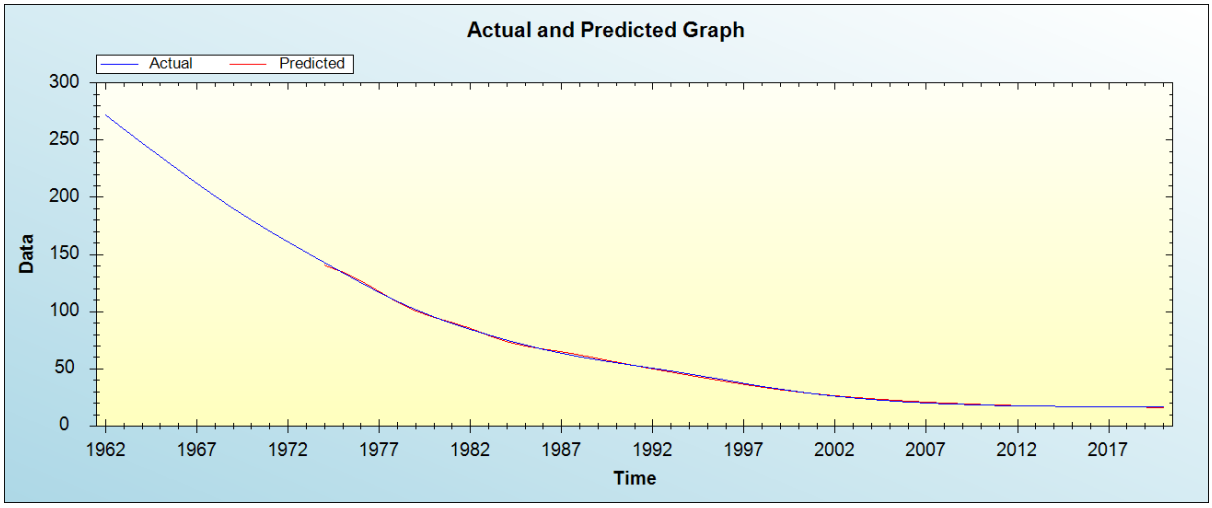

Figure 2: In-sample forecast for the N series

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

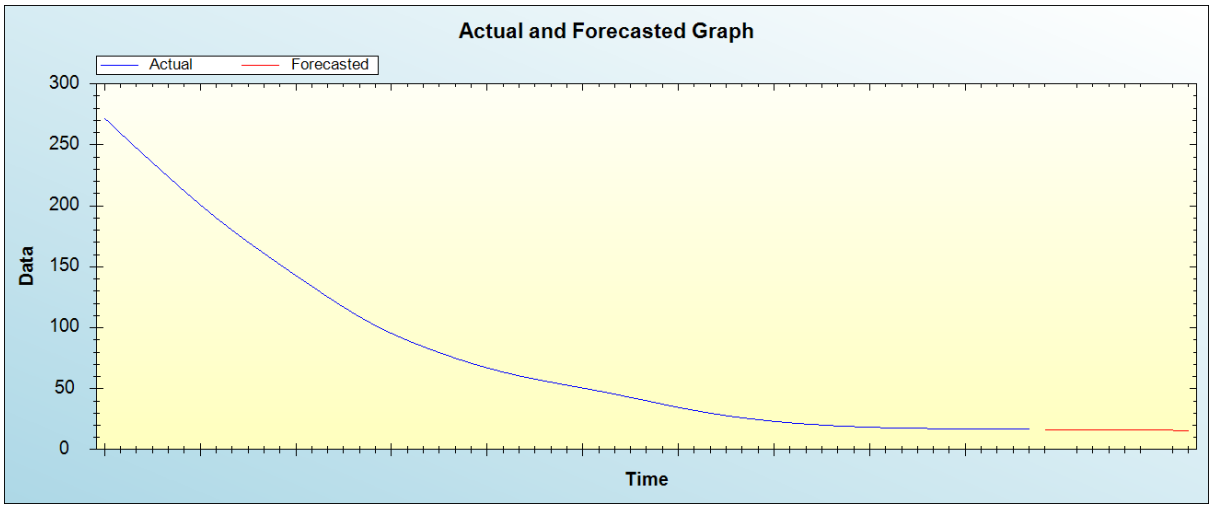

Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	16.2797
2022	16.1577
2023	16.0549
2024	15.9812
2025	15.9134
2026	15.8937
2027	15.8793
2028	15.8753
2029	15.8664
2030	15.8343

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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 hover around 16 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Ending all preventable under five deaths is the aim of SDG3 target 3.2 which focuses on the substantial reduction of under-five mortality to levels as low as 25 deaths per 1000 live births by 2030. All UN member states should channel resources to the maternal and child health program to facilitate successful implementation of SDG3. The ANN model was applied in this study to project the future path of under-five mortality in Tunisia and forecast results indicate thatU5MR will hover around 16 deaths per 1000 live births throughout the out of sample period. Hence, the Tunisian government must address all the challenges that affect successful implementation of SDG3.

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