

# Modelling and Forecasting Immunization against Measles Disease in Djibouti Using Artificial Neural Networks (ANN)

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**Abstract** - In this research article, the ANN approach was applied to analyze child immunization rate in Djibouti. The employed annual data covers the period 1982-2019 and the out-of-sample period ranges over the period 2020-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is very stable. The ANN (12, 12, 1) model projections suggest that child immunization against measles in Djibouti is likely to remain around 90% per year over the next decade. The government is encouraged to intensify child health surveillance and control programs in the country. This can be specifically done by adopting the suggested policy recommendations.

**Keywords:** Measles Disease, Artificial Neural Networks, ANN.

## I. INTRODUCTION

Djibouti is among the Eastern Mediterranean Region (EMR), 22 countries committed to end the endemic of measles, WHO. (2021). Focus was on eradicating measles in these counties by 2020, however with the onset of COVID-19 this may however have not transpired as planned. Crucial tactics for achieving measles elimination in the region involved attaining and maintaining a 90% vaccination coverage of infants with the first dose of measles-containing vaccine (MCV1) in every district of each republic through routine immunization services. For a country ranked 150th out of 177 on the UNDP Human Development Index, Djibouti is ranked as a least developed and food-deficit country, 60% of the population live under the national poverty line, (WHO, 2021). Djibouti's infant and under-five mortality cases are among the greatest in Sub-Saharan Africa, poor health status of children is mostly a result of widespread malnutrition, (WHO, 2011). More than 30% of children under five suffer from malnutrition, accounting for a third of all deaths in that age group. Vaccination coverage is low this is due to the poor utilization rate of amenities, unavailability of immunization services and inaccessible geography in some regions, Naouriet al (2011). Naouriet al (2011), went on to summarize the impact of measles elimination strategies on the interruption of measles transmission in the EMR during the period 1990–2009 and the challenges that remain to reach the goal. No other studies attempted to forecast or model immunization routines in Djibouti. According to WHO, (2011), Djibouti has a 73% measles vaccination coverage. This is generally a low coverage and has been seen to be ascribed to the lack of access to health facilities especially in the inaccessible and remote areas of the country. A study by reported that it is in these areas where measles outbreaks emanate from. Considering the low vaccine coverage complemented by the high poverty and malnutrition levels, combating the endemic of measles has been difficult. More studies that help devise more strategies and improve policy formulation in Djibouti are needed. In an attempt to predict how measles will spread in Djibouti and to influence public health interventions in the country to achieve the greatest impact, the current paper will model and forecast daily measles case volumes in Djibouti. To date no study has attempted to do this and hence this paper will be of great significance in modelling future health interventions

## II. METHODOLOGY

The Artificial Neural Network (ANN), which we intend to apply in this study; is a data processing system consisting of a huge number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from any data-set to describe the nonlinear and interaction effects with great accuracy. Arguably, explicit guidelines exist for the determination of the ANN structure hence 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 infant mortality rates in Djibouti.

**Data Issues**

This study is based on annual rates of immunization of children against measles in Djibouti for the period 1982 – 2019. The out-of-sample forecast covers the period 2020 to 2030. Child immunization; for the purposes of this study, is defined as the percentage of children aged 12-23 months who received the measles vaccination in a given year. All the data employed in this paper was gathered from the World Bank.

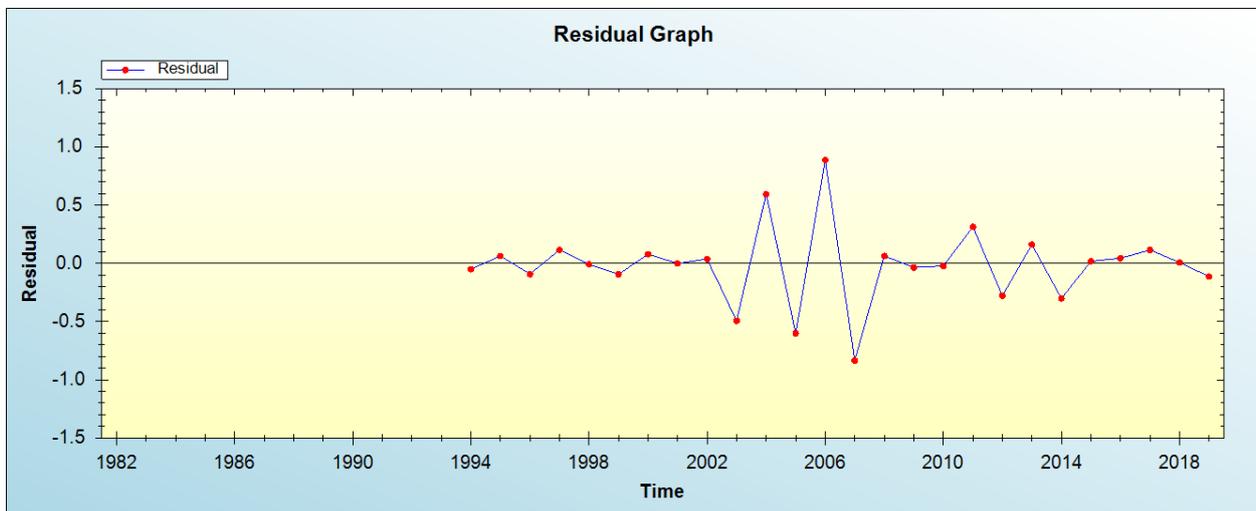
**III. FINDINGS OF THE STUDY**

**ANN Model Summary**

**Table 1: ANN model summary**

Variable	Z
Observations	26 (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	0.006882
MSE	0.108126
MAE	0.208483

*Residual Analysis for the Applied Model*



**Figure 1: Residual analysis**

*In-sample Forecast for Z*

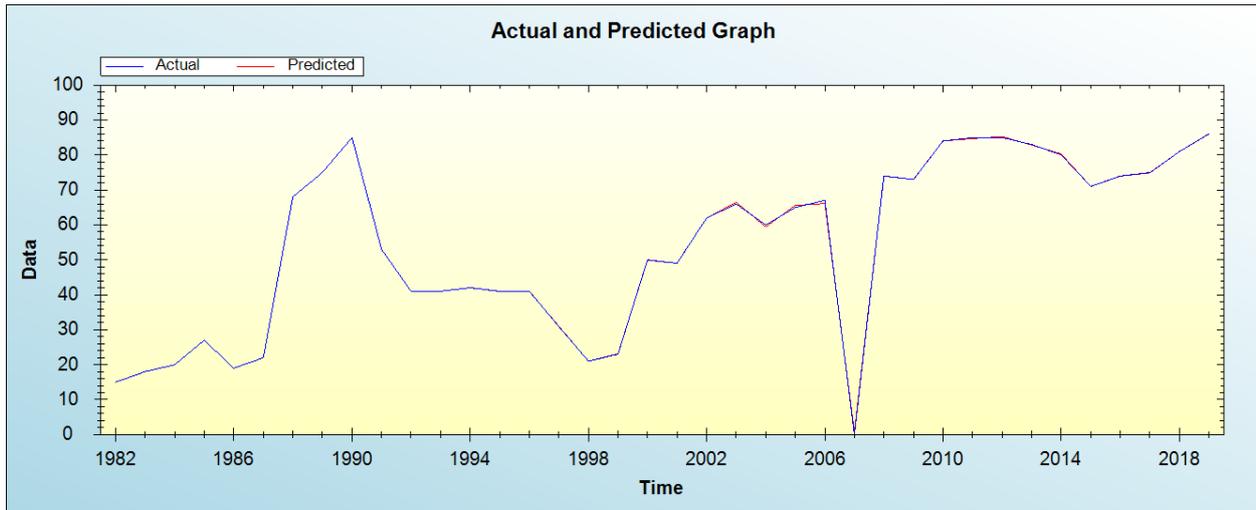


Figure 2: In-sample forecast for the Z series

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

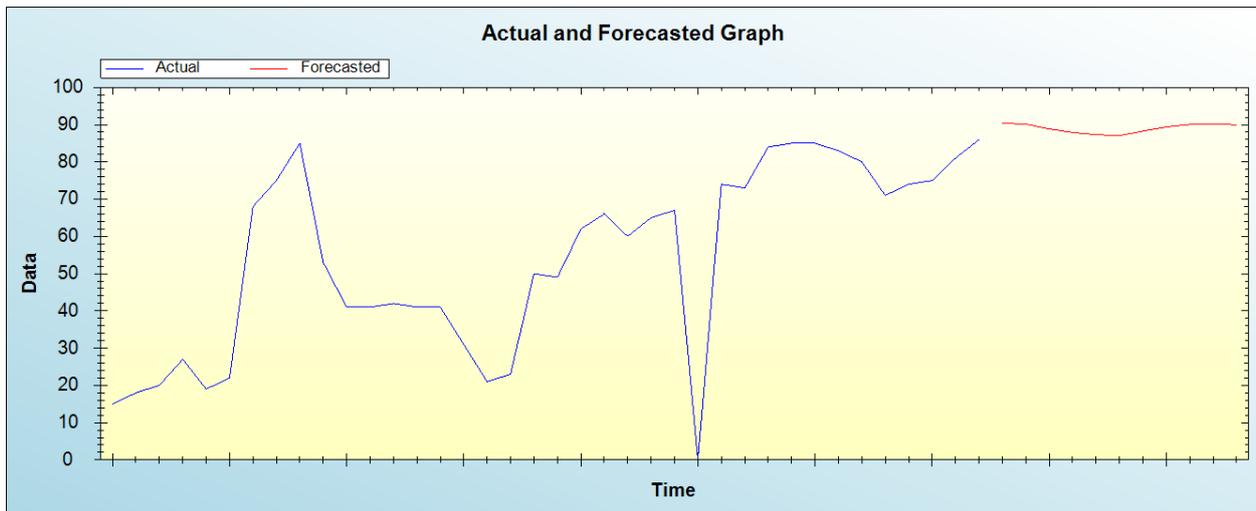


Figure 3: Out-of-sample forecast for Z: actual and forecasted graph

Out-of-Sample Forecast for Z: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2020	90.4035
2021	90.1148
2022	88.8468
2023	87.9064
2024	87.3176
2025	87.0538
2026	88.2769
2027	89.3803
2028	90.0338
2029	90.0988
2030	89.9746

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 child immunization against measles in Djibouti is likely to remain around 90% per year over the next decade.

#### IV. CONCLUSION AND POLICY RECOMMENDATIONS

The measles endemic continues to rapidly spread across the globe with high mortality, severely straining health systems and causing devastating social disruptions and economic damage especially for developing nations like Djibouti. Just like most developing countries with fragile healthcare systems, Djibouti Nepal has already suffered significantly to the endemic, coupled with the food crisis and emergence of new infectious diseases like COVID-19, WHO, (2021). Emphasis is on the health ministry to expand basic health service coverage in rural districts, as they are the ones largely affected. Adherence to WHO sanitary rules and supporting national priority health programmes and basic services, including surveillance and outbreak control, mother and child health, immunization, mental health, education is advised.

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