Forecasting Covid-19 New Cases in Zambia

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Abstract - **In this work, the ANN approach was employed to analyze COVID-19 case volumes in Zambia. This study is based on daily new cases of COVID-19 in Zambia for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the model indicate that it is stable. It is projected that the COVID-19 pandemic is likely to subside significantly around mid-April 2021. The Zambian government ought to ensure the continued compliance to COVID-19 mitigation measures such as social distancing, quarantine, isolation, as well as face-mask wearing, including vaccinations amongst other measures.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

COVID-19 is a deadly viral disease quickly spreading throughout the world. Its main symptoms include fever, sore throat, coughing and difficulty in breathing. The first cases appeared in Wuhan, China, in late December 2019 and the gradually, cases started coming up in many other countries as well (Singhal *et al*., 2020). The increasing number of new infections and death toll the virus has been a major threat and serious challenge for each and every country (Pathak *et al*., 2020). Accurately forecasting the transmission dynamics of confirmed COVID-19 cases is vital to understand and help decision makers to slow down or arrest its spreading (Velasquez & Lara, 2020; Yousaf *et al*., 2020; Ribeiro *et al*., 2020). The main purpose of this study is model and forecast daily confirmed cases of COVID-19 in Zambia.

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 new COVID-19 cases in Zambia.

Data Issues

This study is based on daily new cases of COVID-19 in Zambia for the period 1 January 2020 – 25 March 2021.The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021.All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	Z
Observations	438 (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	0.093045
MSE	8618.911250
MAE	52.271127

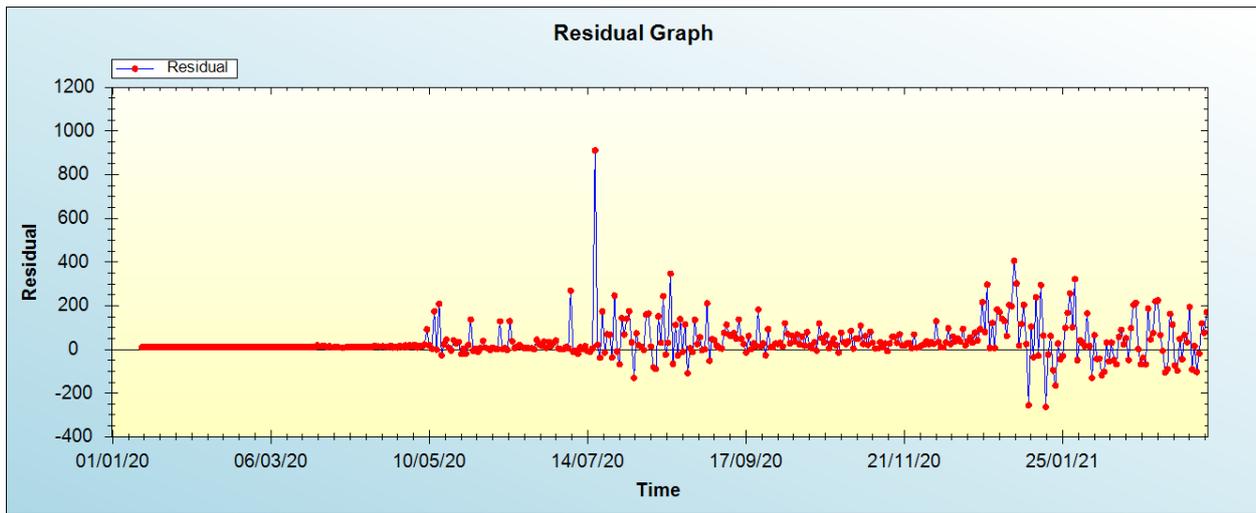*Residual Analysis for the Applied Model*

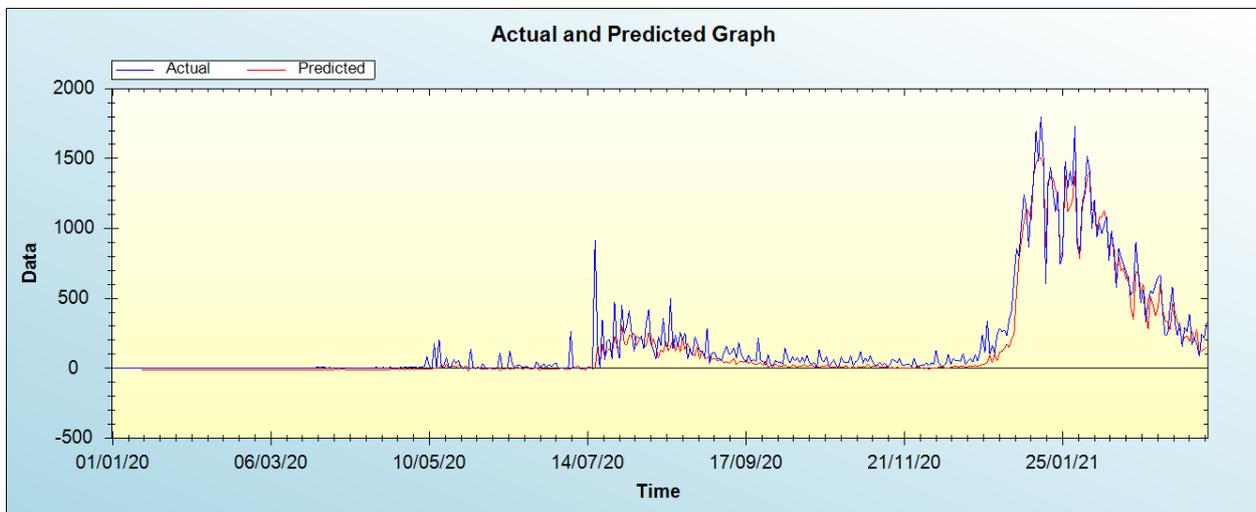**Figure 1: Residual analysis**

In-sample Forecast for Z

Figure 2: In-sample forecast for the Z series

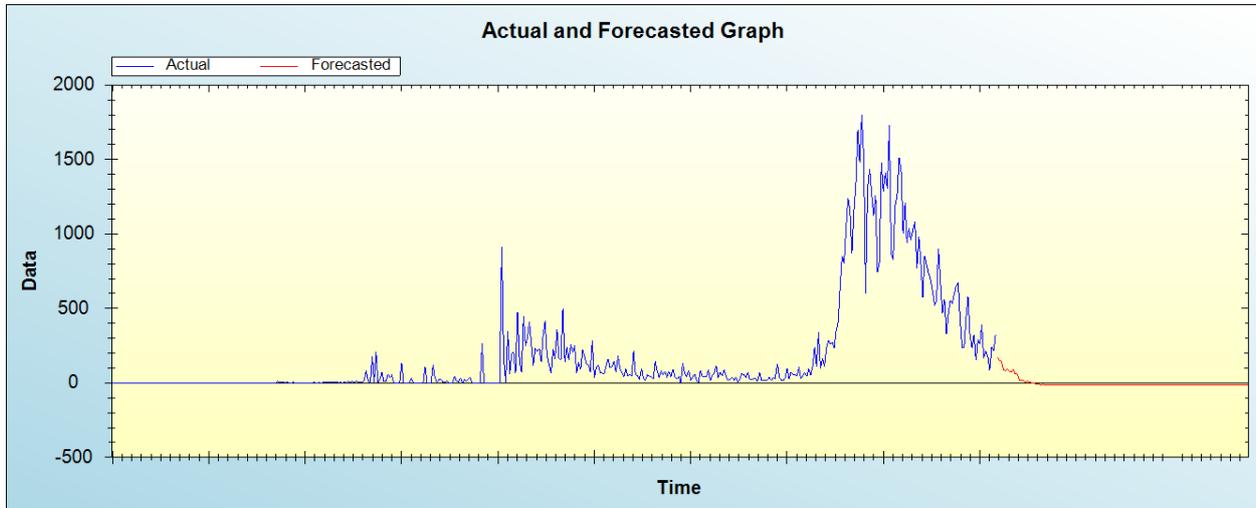*Out-of-Sample Forecast for Z: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for Z: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
26/03/21	171.5119
27/03/21	152.8475
28/03/21	144.9388
29/03/21	88.1805
30/03/21	79.7098
31/03/21	92.2230
01/04/21	78.3277
02/04/21	73.3867
03/04/21	89.3266
04/04/21	60.6859
05/04/21	59.3201
06/04/21	20.8326
07/04/21	20.6525
08/04/21	16.9989
09/04/21	5.0740
10/04/21	9.0389
11/04/21	7.4883
12/04/21	2.0371
13/04/21	0.1636
14/04/21	-3.0387
15/04/21	-8.1052
16/04/21	-9.1462
17/04/21	-12.4806
18/04/21	-10.2655
19/04/21	-11.4171
20/04/21	-12.3842
21/04/21	-11.5103
22/04/21	-12.7798
23/04/21	-13.4305
24/04/21	-13.5716
25/04/21	-13.9579
26/04/21	-14.0213
27/04/21	-13.9489
28/04/21	-13.9757
29/04/21	-13.6934
30/04/21	-14.0434
01/05/21	-14.0296

Date	Value
02/05/21	-13.9825
03/05/21	-14.1872
04/05/21	-14.1272
05/05/21	-14.1026
06/05/21	-14.1045
07/05/21	-14.0752
08/05/21	-14.0834
09/05/21	-14.0763
10/05/21	-14.0821
11/05/21	-14.1277
12/05/21	-14.0963
13/05/21	-14.1017
14/05/21	-14.1135
15/05/21	-14.0910
16/05/21	-14.0947
17/05/21	-14.0953
18/05/21	-14.0959
19/05/21	-14.0993
20/05/21	-14.0974
21/05/21	-14.1010
22/05/21	-14.1011
23/05/21	-14.0954
24/05/21	-14.0986
25/05/21	-14.0980
26/05/21	-14.0961
27/05/21	-14.0982
28/05/21	-14.0980
29/05/21	-14.0983
30/05/21	-14.0982
31/05/21	-14.0978
01/06/21	-14.0983
02/06/21	-14.0976
03/06/21	-14.0975
04/06/21	-14.0981
05/06/21	-14.0978
06/06/21	-14.0978
07/06/21	-14.0981
08/06/21	-14.0979
09/06/21	-14.0979
10/06/21	-14.0978
11/06/21	-14.0979
12/06/21	-14.0979
13/06/21	-14.0978
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25/07/21	-14.0979
26/07/21	-14.0979
27/07/21	-14.0979
28/07/21	-14.0979
29/07/21	-14.0979
30/07/21	-14.0979
31/07/21	-14.0979

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 the COVID-19 pandemic is likely to subside significantly around mid-April 2021.

IV. CONCLUSION & RECOMMENDATIONS

Based on daily observations of COVID-19 cases in Zambia, this study used the ANN (12, 12, 1) model to come up with forecasts ranging over the specified period. The results of the study suggest that the COVID-19 pandemic is likely to subside significantly around mid-April 2021. The Zambian government ought to ensure the continued compliance to COVID-19 mitigation measures such as social distancing, quarantine, isolation, face-mask wearing and so on., including COVID-19 vaccine uptake.

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