Forecasting Covid-19 Deaths in Panama

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Abstract - **In this study, the ANN approach was applied to analyze COVID-19 new deaths in Panama. The employed data covers the period 1January 2020 to 20 April 2021 and the out-of-sample period ranges over the period 21 April 2021 to 31 August 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is quite stable. The results of the study indicate that daily COVID-19 deaths in Panama are likely to range between 3 and 50 deaths per day over the out-of-sample period. Therefore there is need for the government of Panama to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and speed up COVID-19 vaccine roll out.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The COVID-19 outbreak started in late December 2019 in Wuhan city of China before spreading quickly to many regions of the world (WHO, 2020; Wang et al, 2020; Read et al, 2020; Tang et al, 2020). Panama is one of the Latin American countries which did not escape the COVID-19 pandemic. As of the 19 of June 2021the country had recorded 392 166 positive cases, 6 465 deaths and 375 487 recoveries (Worldometer, 2021). Vaccine roll out in the country is lagging behind just like other countries in the region. By the 15th of June 2021 the country had reported a total of 89 151 people who had received at least one vaccine dose representing 21 % of the population and a total of 436 848 people had been fully vaccinated against COVID-19 representing 10.3 % of the total population (Our World in data, 2021). The COVID-19 epidemic has brought numerous challenges to Panama. The country has witnessed a surge in the number of COVID-19 infections coupled with an increase in hospital admissions and increased demand of medical supplies (World Bank, 2020). In addition, high levels of chronic diseases and the ageing population puts Panama at an increased risk of COVID-19 complications (World Bank, 2020). The purpose of this study is to predict daily COVID-19 deaths in Panama using a machine learning algorithm. The results of the study are envisioned to reveal the likely future trends of COVID-19 deaths in the country and facilitate planning and decision making to mobilize resources for the COVID-19 response.

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 COVID-19 deaths in Panama.

Data Issues

This study is based on daily COVID-19 deaths in Panama for the period 1 January 2020 – 20 April 2021.The out-of-sample forecast covers the period 21 April – 31 August 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	P

Observations	464 (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	0.133565
MSE	20.487910
MAE	3.487120

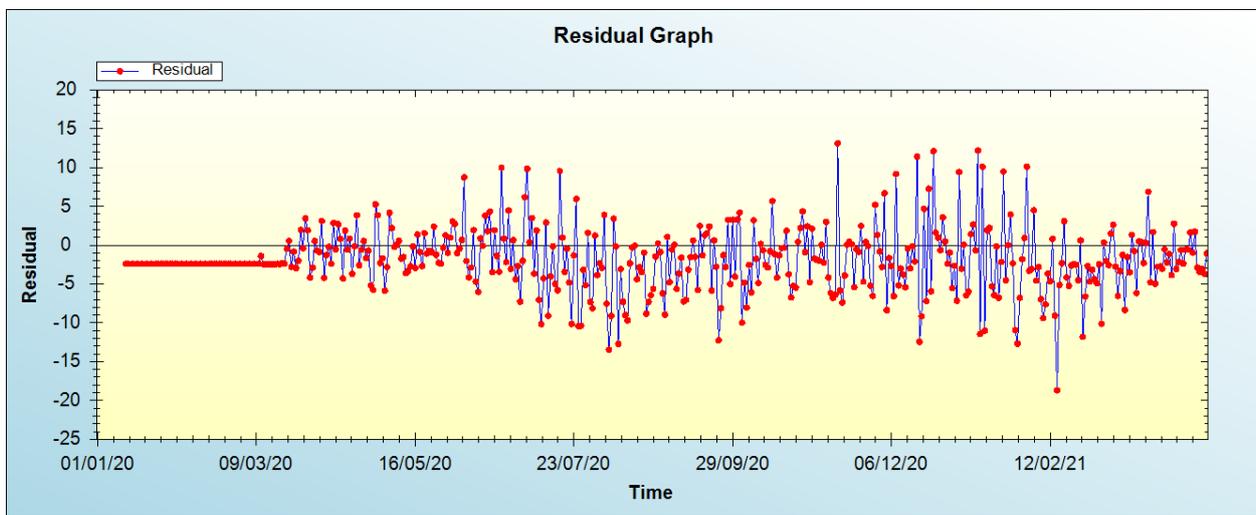*Residual Analysis for the Applied Model*

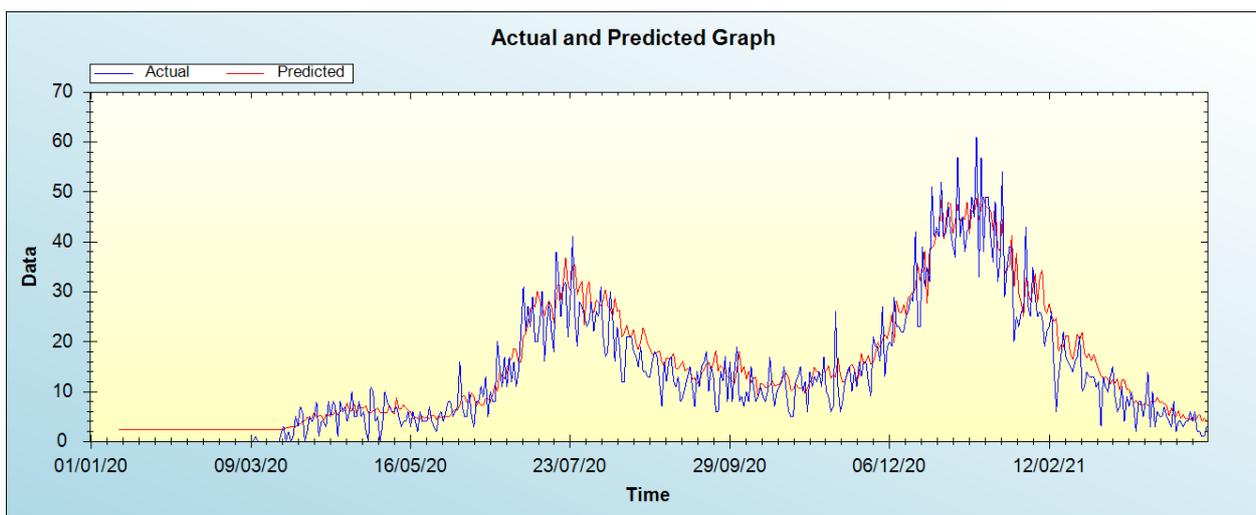**Figure 1: Residual analysis**

In-sample Forecast for P

Figure 2: In-sample forecast for the P series

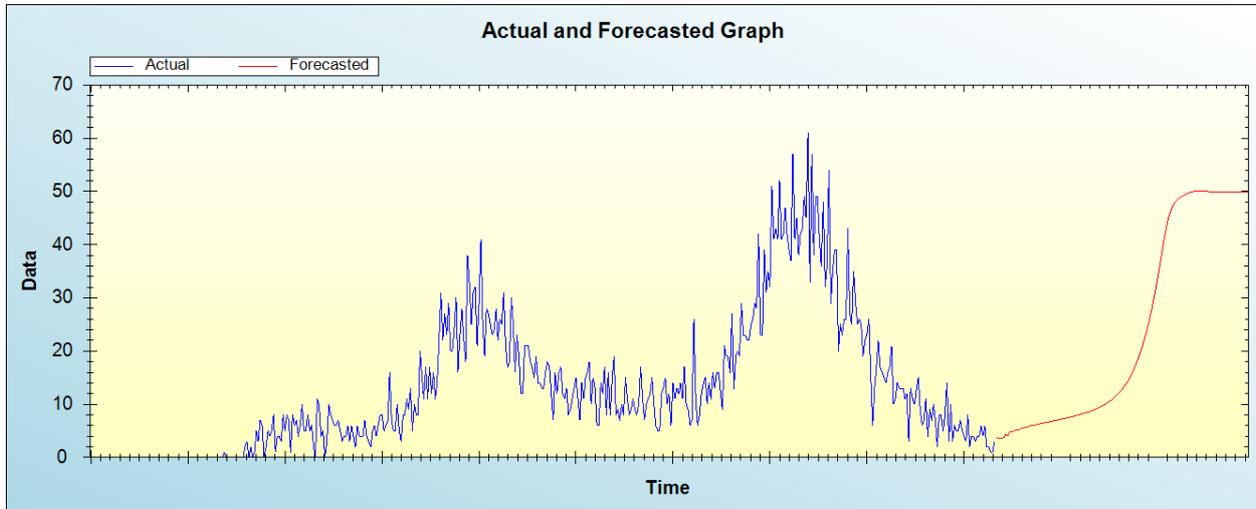*Out-of-Sample Forecast for P: Actual and Forecasted Graph*

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

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Date	Forecasts
21/04/21	3.9243
22/04/21	3.5227
23/04/21	3.6503
24/04/21	3.5912
25/04/21	3.7473
26/04/21	4.3968
27/04/21	4.0828
28/04/21	4.7436
29/04/21	4.8299
30/04/21	4.9185
01/05/21	5.1637
02/05/21	5.1739
03/05/21	5.1878
04/05/21	5.4575
05/05/21	5.4887
06/05/21	5.6814
07/05/21	5.7885
08/05/21	5.7781
09/05/21	5.9591
10/05/21	5.9841
11/05/21	6.0671
12/05/21	6.1944
13/05/21	6.2416
14/05/21	6.3319
15/05/21	6.4294
16/05/21	6.4672
17/05/21	6.5740
18/05/21	6.6329
19/05/21	6.7023
20/05/21	6.8016
21/05/21	6.8584
22/05/21	6.9412
23/05/21	7.0236
24/05/21	7.0877
25/05/21	7.1762
26/05/21	7.2538

27/05/21	7.3298
28/05/21	7.4223
29/05/21	7.4991
30/05/21	7.5882
31/05/21	7.6801
01/06/21	7.7661
02/06/21	7.8649
03/06/21	7.9620
04/06/21	8.0612
05/06/21	8.1702
06/06/21	8.2772
07/06/21	8.3922
08/06/21	8.5135
09/06/21	8.6369
10/06/21	8.7709
11/06/21	8.9101
12/06/21	9.0565
13/06/21	9.2142
14/06/21	9.3792
15/06/21	9.5562
16/06/21	9.7459
17/06/21	9.9475
18/06/21	10.1658
19/06/21	10.4001
20/06/21	10.6531
21/06/21	10.9282
22/06/21	11.2260
23/06/21	11.5510
24/06/21	11.9061
25/06/21	12.2942
26/06/21	12.7205
27/06/21	13.1886
28/06/21	13.7034
29/06/21	14.2704
30/06/21	14.8940
01/07/21	15.5797
02/07/21	16.3321
03/07/21	17.1550
04/07/21	18.0518
05/07/21	19.0244
06/07/21	20.0746
07/07/21	21.2042
08/07/21	22.4169
09/07/21	23.7190
10/07/21	25.1212
11/07/21	26.6374
12/07/21	28.2834
13/07/21	30.0721
14/07/21	32.0076
15/07/21	34.0766
16/07/21	36.2405
17/07/21	38.4308
18/07/21	40.5538
19/07/21	42.5076
20/07/21	44.2055
21/07/21	45.5954
22/07/21	46.6679
23/07/21	47.4512
24/07/21	48.0002
25/07/21	48.3832
26/07/21	48.6684
27/07/21	48.9102
28/07/21	49.1391
29/07/21	49.3605

30/07/21	49.5630
31/07/21	49.7319
01/08/21	49.8593
02/08/21	49.9467
03/08/21	50.0009
04/08/21	50.0294
05/08/21	50.0390
06/08/21	50.0357
07/08/21	50.0250
08/08/21	50.0115
09/08/21	49.9978
10/08/21	49.9846
11/08/21	49.9723
12/08/21	49.9610
13/08/21	49.9515
14/08/21	49.9441
15/08/21	49.9385
16/08/21	49.9346
17/08/21	49.9320
18/08/21	49.9305
19/08/21	49.9299
20/08/21	49.9299
21/08/21	49.9304
22/08/21	49.9311
23/08/21	49.9319
24/08/21	49.9326
25/08/21	49.9334
26/08/21	49.9340
27/08/21	49.9346
28/08/21	49.9350
29/08/21	49.9353
30/08/21	49.9355
31/08/21	49.9357

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 daily COVID-19 deaths in Panama are likely to range between 3 and 50 deaths per day over the out-of-sample period.

IV. CONCLUSION AND POLICY RECOMMENDATIONS

Latin America is in the midst of the COVID-19 health crisis and countries in this region are lagging behind in their COVID-19 vaccination programmes. The health impact of COVID-19 in this part of the world has been very severe with high numbers being recorded in countries like Brazil, Mexico, Argentina and Peru. The Brazilian COVID-19 variant which is highly transmissible has resulted in high infections and deaths. Forecasting of COVID-19 mortality in these countries becomes very important in order to detect likely future trends of COVID-19 mortality. In this piece of work an artificial intelligence technique has been applied to predict daily COVID-19 deaths in Panama and the results of the study indicate that daily COVID-19 deaths in Panama are likely to range between 3 and 50 deaths per day over the out-of-sample period. Therefore the authorities in Panama are strongly encouraged to speed up COVID-19 vaccination in order to quickly attain herd immunity.

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Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 Deaths in Panama" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 830-835, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506145

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