

# Applying Holt's Linear Method in Forecasting Adolescent Fertility for Solomon Islands

<sup>1</sup>Smartson. P. NYONI, <sup>2</sup>Thabani NYONI

<sup>1</sup>ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

<sup>2</sup>Independent Researcher & Health Economist, Harare, Zimbabwe

**Abstract** - This study uses annual time series data of adolescent fertility rate for Solomon Islands from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The study utilizes Holt's linear exponential smoothing model. The optimal values of smoothing constants  $\alpha$  and  $\beta$  are 0.9 and 0.5 respectively based on minimum MSE. The results of the study indicate that annual adolescent fertility is expected to increase and remain high throughout the out of sample period. In order to reverse the projected trend of adolescent fertility, authorities in Solomon Islands should persistently enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and scale up awareness campaigns among communities in order to curb teenage pregnancy and child marriage.

**Keywords:** Exponential smoothing, Forecasting, adolescent fertility rate.

## I. INTRODUCTION

The Agenda 2030 for sustainable development was designed to address key issues that impact human lives around the world. Ensuring good health and promotion of well-being for all at every stage of life is the aim of the 3<sup>rd</sup> sustainable development goal (UN, 2015). Under this goal, all UN member states should aim to substantially reduce adverse maternal and child health outcomes by 2030. The target is to achieve maternal mortality which is below 70 per 100 000 live births, under five mortality of at least 25 deaths per 1000 live births and a neonatal mortality of at least 12 deaths per 1000 live births (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). In 2017, above 800 women around the world died every day from preventable causes related to pregnancy and childbirth complications (WHO, 2018; Kennedy *et al.* 2011; UNFPA, 2009). Many of these deaths occurred in low and middle income countries (LMICs) including those in the Pacific region (Alkema *et al.* 2013). Studies conducted in the past established that adolescent females and women living in rural areas have greater risks of unplanned pregnancies, complications and death compared to other women (Raman *et al.* 2015; Kennedy *et al.* 2013b). Strategies to control this public health problem includes health education, contraception knowledge and access to appropriate health services to empower women and men to make informed decisions about their reproductive choices (WHO, 2015). SDG3 target 3.7 aims at improving the quality of sexual and reproductive health services including that of adolescents. Teenage pregnancy continues to be a public health challenge all over the world including the Pacific islands. In Solomon Islands, 35% of married women and 83% of sexually active unmarried women are not using contraception despite wanting to avoid pregnancy (SINSO *et al.* 2017). Unintended pregnancy is very high, with 57% of all women between 15-49 years reporting that their last pregnancy was unplanned (Kluckowand Panisi, 2018). The uptake of contraception is very low and rates are decreasing. HIV prevalence is very low whereas syphilis rates are high especially in the sex worker community (MHMS Solomon Islands Government, 2018). The government of Solomon Islands crafted the National Youth Policy (2017-2030). Through this policy, the government has identified sexual and reproductive health, including teenage pregnancy, as a health priority. In addition, the National Health Strategic Plan (2016-2020) was to develop a youth and adolescent-specific health strategy (MHMS, 2016). Youth-friendly interventions were designed to provide information, education and adolescent-friendly SRH services to influence contraceptive practice and condom use, reduce unintended pregnancies and STI among the general population, and improve SRH outcomes of the islanders (SIPPA, 2020).

In line with the country's National Youth Policy (2017-2030), the purpose of this study is to model and forecast future trends of adolescent fertility for Solomon Islands. The findings are expected to highlight likely future trends of adolescent births in the country. This in turn will inform policy making, planning and allocation of resources towards programs which are designed to reduce teenage pregnancy and child marriages.

## II. METHODOLOGY

This study utilizes an exponential smoothing technique to model and forecast future trends of adolescent fertility rate in Solomon Islands. In exponential smoothing forecasts are generated from the smoothed original series with the most recent historical values having more influence than those in the more distant past as more recent values are allocated more weights than those in the distant past. This study uses the Holt's linear method (Double exponential smoothing) because it is an appropriate technique for modeling linear data.

Holt's double exponential smoothing method is expressed as follows:

### Model equation

$$Y_t = \mu_t + \rho_t t + \varepsilon_t$$

### Smoothing equation

$$L_t = \alpha Y_t + (1-\alpha)(L_{t-1} + b_{t-1})$$

$$0 < \alpha < 1$$

### Trend estimation equation

$$b_t = \beta (L_t - L_{t-1}) + (1-\beta)b_{t-1}$$

$$0 < \beta < 1$$

### Forecasting equation

$$f_{t+h} = L_t + hb_t$$

$Y_t$  is the adolescent fertility rate at time  $t$

$\varepsilon_t$  is the time varying **error term**

$\mu_t$  is the time varying mean (**level**) term

$\rho_t$  is the time varying **slope term**

$t$  is the trend component of the time series

$L_t$  is the exponentially smoothed value of adolescent fertility rates at time  $t$

$\alpha$  is the exponential smoothing constant for the data

$\beta$  is the smoothing constant for trend

$f_{t+h}$  is the  $h$  step ahead forecast

$b_t$  is the trend estimate at time  $t$

$b_{t-1}$  is the trend estimate at time period  $t-1$

### **Data Issues**

This study is based on annual adolescent fertility rate in Solomon Islands for the period 1960 – 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.

### III. FINDINGS OF THE STUDY

#### Exponential smoothing Model Summary

Table 1: ES model summary

Variable	Y
Included Observations	61
Smoothing constants	
Alpha ( $\alpha$ ) for data	0.900
Beta ( $\beta$ ) for trend	0.500
Forecast performance measures	
Mean Absolute Error (MAE)	3.340807
Sum Square Error (SSE)	3589.657729
Mean Square Error (MSE)	58.846848
Mean Percentage Error (MPE)	0.423788
Mean Absolute Percentage Error (MAPE)	4.726384

#### Residual Analysis for the Applied Model

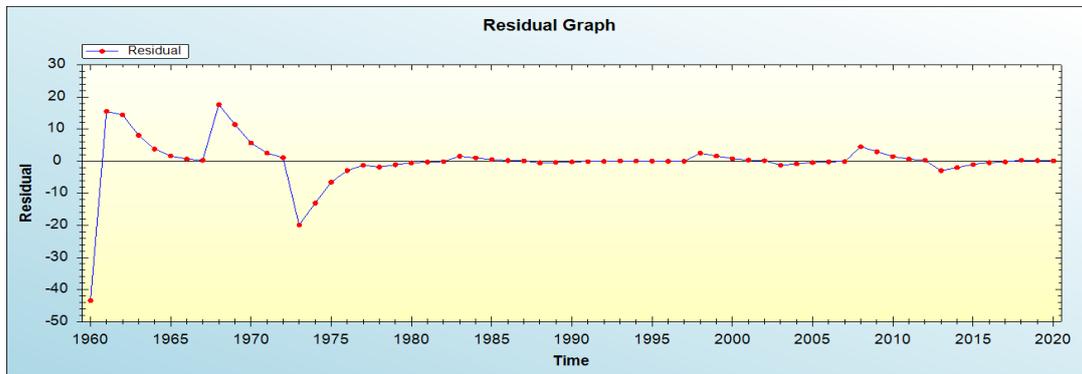


Figure 1: Residual analysis

#### In-sample Forecast for Y

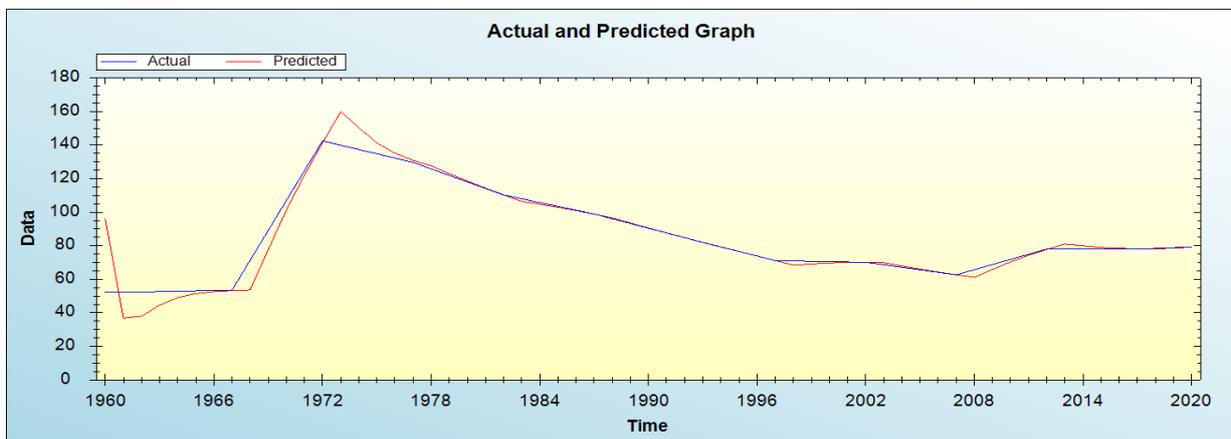


Figure 2: In-sample forecast for the Y series

Actual and Smoothed graph for Y series

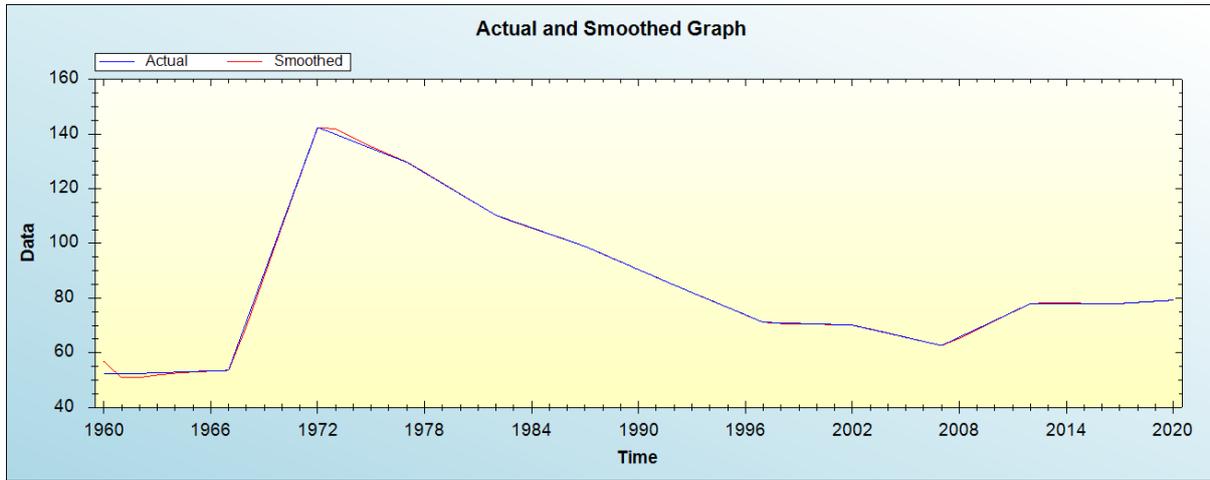


Figure 3: Actual and smoothed graph for Y series

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

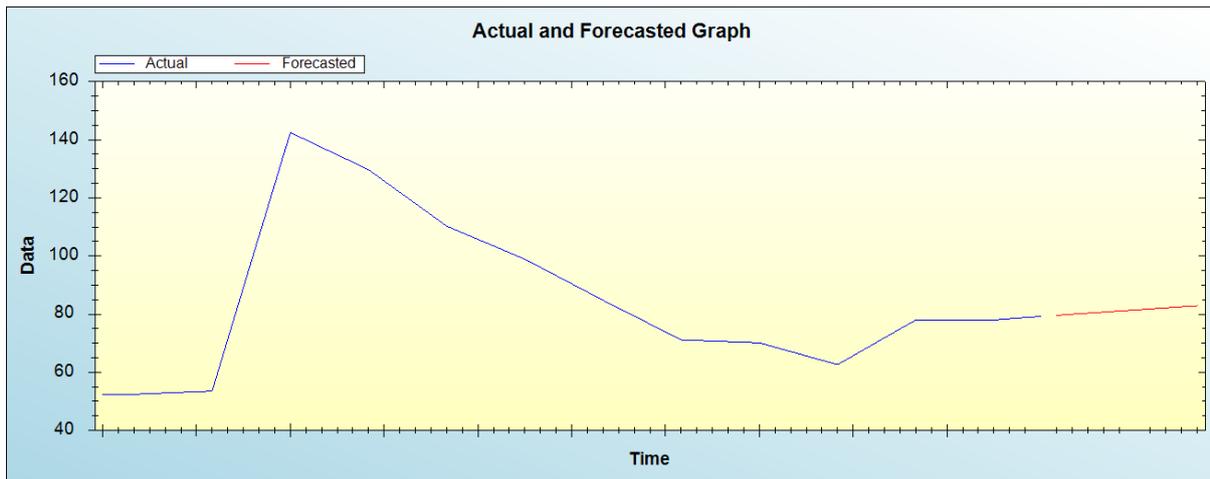


Figure 4: Out-of-sample forecast for Y: actual and forecasted graph

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Year	Projected adolescent fertility rate
2021	79.5835
2022	79.9501
2023	80.3167
2024	80.6833
2025	81.0500
2026	81.4166
2027	81.7832
2028	82.1498
2029	82.5164
2030	82.8830

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 adolescent fertility rate will increase and remain high throughout the out of sample period.

#### IV. POLICY IMPLICATION & CONCLUSION

In Solomon Islands, 35 percent of married women and 83 percent of sexually active unmarried women are not using contraception despite wanting to avoid pregnancy. Unintended pregnancy is very high, with 57 percent of all women between 15-49 years reporting that their last pregnancy was unplanned. The uptake of contraception is very low and rates are decreasing. As revealed by the World Bank, adolescent fertility for Solomon Islands gradually declined from 142 births per 1000 women aged 15-19 years in 1972 to 79 births per 1000 women aged 15-19 years in 2020. This study applies Holt's double exponential smoothing technique to forecast future trends of adolescent fertility for Solomon Islands. Forecast results indicate that adolescent fertility will slightly increase and remain high throughout the out of sample period. Therefore, we encourage authorities in this country to strictly enforce laws that protect sexual and reproductive health rights of women and girls, promote girl child education and scale up awareness campaigns among communities in order to curb child marriage and teenage pregnancy.

#### REFERENCES

- [1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
- [2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
- [3] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [4] UNICEF (2018). Every Child alive. New York: UNICEF
- [5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [6] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.
- [7] WHO (2018). Maternal mortality. <https://www.who.int/news-room/factsheets/detail/maternal-mortality>.
- [8] Kennedy E., Gray N., and P A, M C (2011). Adolescent fertility and family planning in East Asia and the Pacific: a review of DHS reports. *Reproductive Health*. 8(1):1–12. <https://doi.org/10.1186/1742-4755-8-11> PMID: 21545708.
- [9] United Nations Population Fund (2009). ICPD AT 15: ACHEIVEMENTS, CHALLENGES AND PRIORITIES IN THER PACIFIC ISLANDS—Pacific Sub-Regional Review of ICPD POA Implementation. Suva, FIji: 2009.
- [10] Alkema L., Kantorova V., Menozzi C., and Biddlecom A (2013). National, regional, and global rates and trends in contraceptive prevalence and unmet need for family planning between 1990 and 2015: a systematic and comprehensive analysis. *The Lancet*. 381(9878):1642–52. [https://doi.org/10.1016/s01406736\(12\)62204-](https://doi.org/10.1016/s01406736(12)62204-)
- [11] Kennedy EC., Bulu S, J H., Humphreys D J M., and Gray NJ (2013b). 'Be kind to young people so they feel at home': a qualitative study of adolescents' and service providers' perceptions of youth-friendly sexual and reproductive health services in Vanuatu. *BMC Health Services Research*. 13(1):455–. <https://doi.org/10.1186/1472-6963-13-455> PMID: 104008283.
- [12] Raman S., Nicholls R F P., Gapirongo K., and Hou L (2015). Identifying and overcoming barriers to adolescent sexual and reproductive health in the Solomon Islands: perspectives and practices of health, education and welfare workers. *Pacific Journal of Reproductive Health*. 2015(1):4–13. <https://doi.org/10.18313/pjrh.2015.1000>
- [13] World Health Organization (2015). Strategies toward ending preventable maternal mortality. Geneva, Switzerland.
- [14] Solomon Islands National Statistics Office (SINSO), Solomon Islands (Ministry of Health and Medical Services) MHMS and the Pacific Community Solomon Islands Demographic and Health Survey 2015(2017).
- [15] Hannah Kluckow., and Leeanne Panisi (2018). Socio-demographic predictors of unintended pregnancy and late antenatal booking in Honiara, Solomon Islands, (2018) <https://obgyn.onlinelibrary.wiley.com/doi/epdf/10.1111/ajo.12782>
- [16] MHMS Solomon Islands Government. (2018) Global AIDS Monitoring (GAM) [https://www.unaids.org/sites/default/files/country/documents/SLB\\_2018\\_countryreport.pdf](https://www.unaids.org/sites/default/files/country/documents/SLB_2018_countryreport.pdf)
- [17] Solomon Islands Ministry of Health and Medical Services (MHMS). (2016). National Health Strategic Plan 2016-2020 (pp.1–52). <https://daisi.com.au/wp-content/uploads/2016/09/Strategic-Plan-for-SolomonIslands-2016-2010.pdf>
- [18] SIPPA (2020). pp. 1-6.
- [19] Ministry of Women Youth Children and Family Affairs. (2017). Solomon Islands National Youth Policy 2017-2030. <http://www.mwycfa.gov.sb/resources-2/strategic-plans-policies/youth-development-empowerment/6-solomonislands-national-youth-policy-2017-2030/file.html>

**Citation of this Article:**

Smartson. P. NYONI, Thabani NYONI, “Applying Holt’s Linear Method in Forecasting Adolescent Fertility for Solomon Islands” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 2, pp 349-354, February 2023. Article DOI <https://doi.org/10.47001/IRJIET/2022.702058>

\*\*\*\*\*