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RESEARCH ARTICLE

Forecasting of Inland Fish Production: Case of Catla (*Catla catla*) and Gift Tilapia (*Oreochromis niloticus*) Production in Udawalawa Reservoir in Sabaragamuwa Province, Sri Lanka

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ABSTRACT

This study focused on assessing and forecasting Catla (Catla catla) and Tilapia (Oreochromis niloticus) production in the Udawalawe reservoir in Sri Lanka using an 11-year time series data from 2010 to 2021. The relevant secondary data were collected from the National Aquaculture Development Authority of Sri Lanka (NAQDA). Unit root tests, Dickey-Fuller tests, and Seasonal Auto Regressive Integrated Moving Average (SARIMA) models and trend analysis were applied for the data analyses. According to the results, stationarity behaviour was observed in both Catla and Tilapia production information series. Hence, SARIMA (2,2,1) (1,0,1)12 is the appropriate empirical model for forecasting Catla production. Furthermore, the maximum average landings of Catla production were observed in the March-June time period. SARIMA (1,0,1) (1,1,1)12 was indicated as the most suitable model to forecast Tilapia production in the reservoir. The maximum average of Tilapia production was also observed in the March-June period. Both the SARIMA model and trend analysis gave approximately equal production information regarding Catla and Tilapia. Thus, these findings showed that the SARIMA model has more accuracy than trend analysis when analysing the time series information for short durations. However, when the duration becomes larger, forecasting is not suitable using the SARIMA model, and trend analysis gives a clear view up to a certain level. Both Catla and Tilapia production exhibited significant changing patterns and multiple seasonalities. Thus, trend analysis gives valuable insights than SARIMA model in long term predictions in case of this study. These findings are highly important for enhancing fish production in this reservoir, as they predict future fish catches under the current reservoir conditions.

***Keywords**: Forecasting, Inland fish production, Sri Lanka, Time series analysis, Udawalawe reservoir*

INTRODUCTION

Inland fisheries play a vital role in empowering livelihoods and ensuring the food security of many nations due to issues arising in marine fisheries. Additionally, several pieces of evidence (e.g., consumption studies) have reported that inland fisheries harvest is often unrecorded or drastically underreported, particularly concerning the prevalence of small-scale or artisanal fishing (i.e., subsistence and local trade) in inland water bodies (Bartley *et al.*, 2015; FAO, 2018; Arthur *et al.*, 2021). Generally, inland fishery practices in freshwater and brackish water aim to cultivate naturally adapted species or introduced species, including marine species, which can tolerate those environmental conditions to achieve optimum revenue according to farmers' expectations (Mohsin *et al.*, 2017). Diverse farming systems are obtained in the inland fishery sector through the rapid improvement of integrated inland fishery systems, resulting in optimum productivity and utilization efficiency of improved resources while minimizing environmental impact (FAO, 2020).

In 2020, inland farming systems produced 54.4 million tonnes of aquatic animals, providing 62.2 percent of the global food fish production (FAO, 2022). Crustacean farming reflects conspicuous growth in Asia. However, finfish production presents a significant contribution to inland fishery, accounting for about 90.2 percent (49 million tonnes) in 2020 (FAO, 2022). Cage culture methods for inland fish farming are a prominent feature in the economies of Indonesia, Turkey, the Philippines, Egypt, and the Russian Federation, while the Philippines and the Russian Federation notably contribute to world inland fish production through pen culture methods (FAO, 2022).

Sri Lanka, with its tropical climate, holds immense potential for thriving inland fishing activities. Abundant natural resources and favorable environmental conditions make it an ideal setting for the development and expansion of inland fisheries. The fisheries sector plays a key role in Sri Lanka's social and economic life, contributing 9.9 percent to the national GDP. Additionally, 1.5 percent of national export earnings were obtained from fish and fishery products in 2020, with 90,340 metric tonnes of products produced in the inland fishery and aquaculture sector (Department of Fisheries, 2020). Moreover, according to NAQDA statistics (2023), inland and aquaculture production reported as 116,890 metric tonnes in 2022, an increase of 12,440 metric tonnes compared to total production in 2021. Inland fish production, mainly from perennial and seasonal reservoirs, increased by 18% to 100,930 metric tonnes compared to 2021. From an economic viewpoint, there is significant scope to increase contribution from this sector by increasing output, exploiting potential for value addition, and improving export situations. Despite the good potential to add value to inland fish and fishery products, Sri Lanka has not successfully applied it (Athukorala *et al.*, 2017; USAID, 2009).

The Udawalawe reservoir is a man-made perennial reservoir, with its water catchment areas mainly filled through the advent of the North-East monsoon rainy season. The northern bank area of the reservoir and the shallow inundated banks of the Walawe River bring water to this reservoir. It acts as a spawning ground for the fishing species cultivated in this reservoir. Additionally, this reservoir is the only natural breeding and spawning ground for Indian carp varieties such as Catla (*Catla catla*), Rohu (*Labeo rohita*), Mrigal (*Cirrhinus* *mrigala*), Tilapia varieties, and freshwater prawn species cultivated in Sri Lanka due to the favorable climatic conditions of the area (Deepananda *et al.*, 2014). Hence, the Udawalawe reservoir is considered the specific reservoir that produces a significant amount of Catla and Tilapia species per unit area compared to other reservoirs in Sri Lanka. Moreover, estimating inland fish production in the Udawalawe reservoir will provide more benefits towards sustainable policy implications to enhance inland fish production further. Thus, this research study aims to develop a model to estimate the Catla and Tilapia fish production of this reservoir as it is a timely and important requirement to identify future directions to expand inland fish production through proper policy implications.

MATERIALS AND METHODS

This study utilized secondary data collected from the National Aquaculture Development Authority (NAQDA) spanning from 2010 to 2021. Its objective was to assess the time series forecasting of inland fish production in the reservoir during this period. The location of the reservoir is illustrated in Figure 01. After verifying the collected data, the Unit Root Test (specifically the Dickey-Fuller test) and SARIMA model were employed for data analysis.

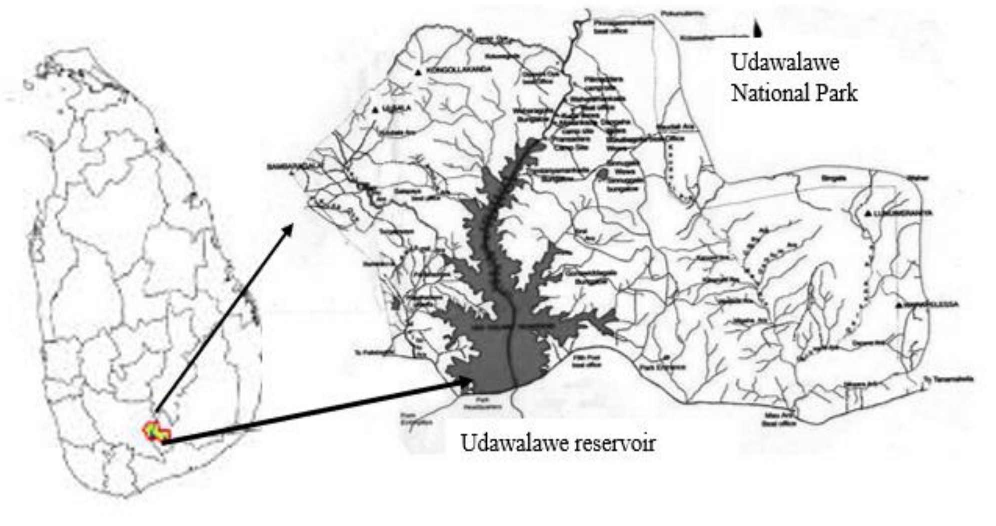

Figure 1: Location of the Udawalawe reservoir (Premathilaka and Athapaththu, 2021)

Despite the cultivation of several Indian carp varieties (Catla; *C. catla*, Rohu; *L. rohita*, and Mrigal; *C. mrigala*), Tilapia varieties (Gift Tilapia), and freshwater prawn species in this reservoir, the study only considered two inland fish species (Catla; *C. catla* and Tilapia species: Gift Tilapia) due to their superior production performance compared to other species. Their higher production is attributed to favorable climatic conditions. Prior to conducting time series forecasting, the

Unit Root Test and the Dickey-Fuller test were employed to ascertain the stationary nature of production information for both Catla and Tilapia species individually. The Dickey-Fuller test, being the most common form of the unit root test, provides a clear indication of the stationary behavior of a given time series, with formula 1 representing the model equation.

$$(1) \quad \Delta Y_t = \gamma Y_{t-1} + \sum_{j-1}^{p} (\delta_j \Delta Y_{t-j}) + e_t$$

$$(2) \quad \Delta Y_t = \alpha + \gamma Y_{t-1} + \sum_{j-1}^{p} (\delta_j \Delta Y_{t-j}) + e_t$$

$$(3) \quad \Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{j-1}^{p} (\delta_j \Delta Y_{t-j}) + e_t$$

Formula 1: Dickey fuller test (Herranz, 2017)

Where,

y(t-1) = lag 1 of time series

delta Y(t-1) = first difference of the series at time (t-1)

Fundamentally, the Dickey-Fuller test shares a similar null hypothesis with the unit root test, aiming to identify the stationary nature of the series. Specifically, the null hypothesis suggests that the coefficient of Y(t-1) equals 1, indicating the presence of a unit root (Herranz, 2017).

Each selected inland fish species' data series comprised 132 observations. Out of these, 120 observations were utilized to construct the Seasonal Auto-Regressive Integrated Moving Average (SARIMA) model, while the remaining 12 observations were reserved for the validation procedure.

The SARIMA model for seasonal quarterly time series data involves four main steps: model identification, parameter estimation, model validation (diagnostic checking), and finally forecasting. This methodology is based on the approach outlined by Ramam and Das (2018).

SARIMA model defined as ARIMA with seasonal parameters denoted as ARIMA (*p,d,q*) (*P,D,Q*) s,

where p = auto regression (*AR*) order, d = differencing order, q = moving average order, P = seasonal AR order, D = seasonal differencing order, Q = seasonal MA order and s is seasonality using the back shift operator B (the operator B is such that Bzt=zt−1) is expressed as,

φ(Bs)ϕ(B) ∇d∇Ds zt = Θ(Bs)θ(B)εt -------------------------------------- E1 where,

$\nabla=1-B$

$\nabla s=1-Bs$

$\phi(B)=1-\phi 1B-\cdots-\phi pBp$

$\theta(B)=1-\theta 1B-\cdots-\theta qBq$

$\varphi(Bs)=1-\varphi 1Bs-\cdots-\varphi P(Bs)P$

$\Theta(Bs)=1-\Theta 1Bs-\cdots-\Theta Q(Bs)Q$

Parameters of the model are

$\phi 1,\cdots,\phi p,\theta 1,\cdots,\theta q,\varphi 1,\cdots,\varphi P,\Theta 1,\cdots,\Theta Q$ and $\sigma 2$.

Now, SARIMA model for time series data y*t* using Eq. (1) can be defined as;

$yt=\varphi(Bs)\phi(B)\nabla d\nabla Dsyt+\Theta(Bs)\theta(B)\varepsilon t$ ------------------------ E2

Moreover, the SARIMAX model (seasonal ARIMA with explanatory variable) can be represented as a time-series forecasting model using the multiple regressions with seasonal ARIMA model that takes care of the residual's serial correlations.

Further, SARIMAX model can be defined using Eq. (2) and regressors as follows;

$y\ t=\varphi(B\ s\ )\phi(B)\nabla\ d\ \nabla D\ s\ yt+\Theta(B\ s\ )\theta(B)\varepsilon t+\beta xt$ ---------------------- E3

Where, x*t* is the input series at time t and β is the regression coefficients of the input series considering the assumptions of ARIMA and regression model together.

Here, the sequence $\varepsilon' tS$ is independently and identically distributed (*i.i.d*) random variable with zero mean and constant variance $\sigma 2$, which represents the error term in the model.

Data analysis was performed using EViews 12 and MS Excel 2016 packages. Model validation was employed to enhance accuracy during the forecasting of time series information.

Additionally, trend analysis was conducted to further forecast the amount of fish production and to compare the findings of both forecasting methods for inland fish production. Trend analysis is a technique utilized in technical analysis that seeks to predict future movements based on recently observed trend data (Hayes, 2023).

RESULTS AND DISCUSSION

The Udawalawe reservoir is situated in Udawalawa area within the Embiliptiya Divisional Secretariat Division, located in the Ratnapura district of Sri Lanka. This reservoir spans an area of 3,399 hectares and is renowned as a prominent inland fishing location in the country.

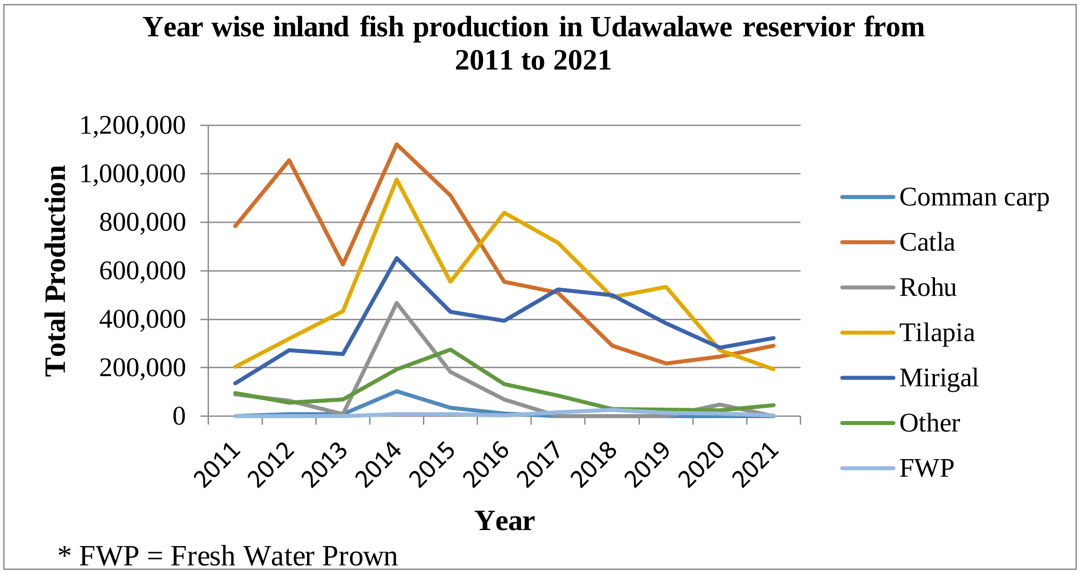

Figure 2: Year wise inland fish production (Mt) in Udawalawe reservoir from 2011 to 2021 (NAQDA, 2021).

From the findings depicted in Figure 2, it is evident that the Udawalawe reservoir consists of various types of inland fishes, including Common carp, Catla, Rohu, Tilapia, Mirigal, and freshwater prawns. Nevertheless, it is noteworthy that Catla and Tilapia varieties emerge as the predominant types of fish, exhibiting a conspicuous level of production on a monthly basis.

Stationarity nature of C. catla production series

The Dickey-Fuller test was employed to ascertain the stationarity nature of the *C. catla* production information series. In this context, the H0a hypothesis was utilized. The results are outlined in Table 1.

H_{0a} There is no stationarity in the Catla production information series from 2011 to 2021.

Table 1: Dickey fuller test – Catla production

Test for unit root in	Include in test equation	Co-efficient	Std error	t statistic	prob.*
Levels	Intercept	(-)0.388	0.069	(-)5.564	0.000
	Trend & intercept	(-)0.484	0.075	(-)6.441	0.000

**prob. < 0.005, stationarity was obtained in Catla production information series from 2011 to 2021.*

According to the results presented in Table 1, the probability values of the unit root test in their levels were assessed considering two aspects: intercept and trend, and intercept aspects of the unit root in their levels. These values were noted as 0.000. Consequently, , the null hypothesis (H_{0a}) was rejected at $p < 0.005$. Therefore, stationarity was observed in the Catla production information series from 2011 to 2021.

Time series analysis of Catla production in Udawalawe reservoir

Catla stands out as one of the primary inland fish varieties found in the Udawalawe reservoir due to its substantial annual production capacity. This is largely attributed to the favourable climatic conditions as well as the physical, chemical, and biological properties of the water within the reservoir.

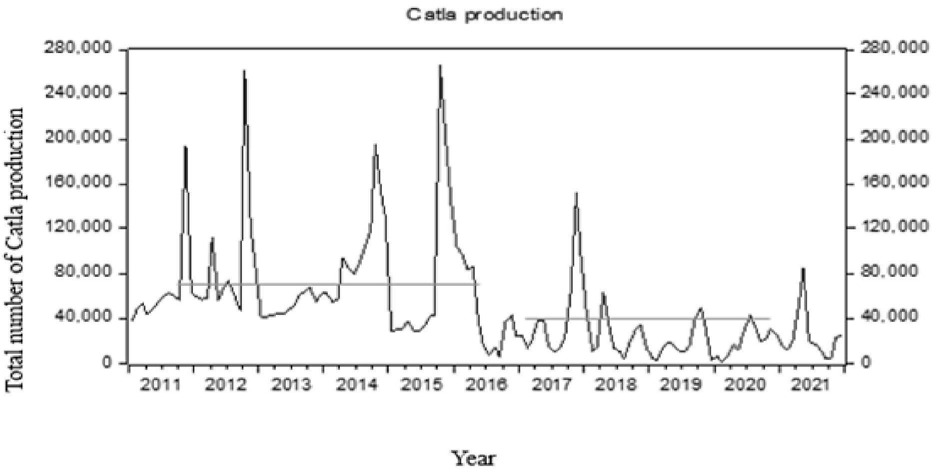

Figure 3: Catla production (Mt) in Udawalawe reservoir from 2011 to 2021

Based on the time series results depicted in Figure 3, notable seasonal production variations were evident in Catla production during the specified period. Specifically, when examining the monthly Catla production information, a conspicuous increase in production was consistently observed between the months of October and December each year.

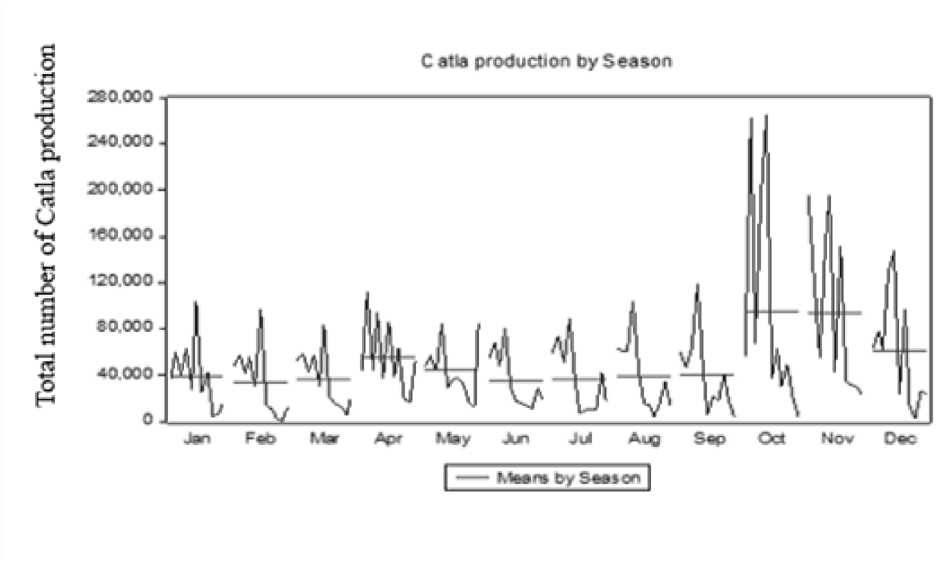

Figure 4: Seasonality pattern in Catla production (Mt) in Udawalawe reservoir from January 1, 2011 to December 31, 2021.

According to the findings illustrated in Figure 4, a conspicuous seasonality pattern was observed in Catla production by season. The month of October consistently exhibited the peak amount of Catla production, while June consistently reported a recession in Catla production.

Monthly wise forecasted Catla production for the time period of January 1, 2021 to December 31, 2021

Table 2 presents a comparison of the forecasted Catla production on a monthly basis with the actual Catla production for the time period spanning from January 1, 2021, to December 31, 2021. According to the results presented in Table 2, the actual values of Catla production closely aligned with its seasonal pattern for the forecasted Catla production during the specified time period. The forecasting of Catla production for the period from January 1, 2021, to December 31, 2021 was conducted as part of the model validation procedure to assess the accuracy of the identified SARIMA model against the actual values. The findings in Table 3 indicated that SARIMA (2,2,1) (1,0,1)12 is the appropriate empirical model for forecasting Catla production.

Table 2: Forecasted Catla production (Mt) for the time period of January 1, 2021 – December 31, 2021

Month	Actual Catla production	Forecasted Catla production
January	15950	19298
February	11462	11748
March	19648	16445
April	52167	45610
May	84839	73544
June	19591	17493
July	17270	13325
August	13608	12580
September	4791	5087
October	4643	5724
November	23054	22302
December	24203	25754

Table 3: Forecasted Catla production (Mt) through the findings of the SARIMA model for the time period of January 1, 2022 – December 31, 2024

Month	Year		
	2022	**2023**	**2024**
January	13770.6	9316.2	8976.7
February	4455.7	10659.6	5567.2
March	13695.8	15053.5	1577.9
April	19410.7	16805.5	18504.3
May	28775.2	24006.6	27367.4
June	1839.8	3817.2	2566.7
July	3103.7	9532.5	7340.5
August	4469.2	11518.2	7896.0
September	6348.0	608.6	3023.7
October	11891.7	13940.2	12545.8
November	18015.7	16270.7	16455.6
December	28126.5	24443.7	28672.2

Monthly wise forecasted Catla production for the time period of January 1, 2022 to December 31, 2024

Table 3 shows the forecasted Catla production information on a monthly basis for the time period from January 1, 2022, to December 31, 2024. Accordingly, the actual values of Catla production closely matched its seasonal pattern for the forecasted Catla production during the specified time period. Notably, the months of October, November, and December consistently exhibited the maximum level of Catla production, consistent with the observations illustrated in Figure 4.

Trend analysis of Catla production

The trend analysis of Catla production is presented in Figure 5. Accordingly, a polynomial trendline pattern was observed for the graph of Catla production time series. However, the R-square value of the chart was reported as 0.2553, indicating a lower R-square value of 25.5% on the right of this curve. The forecasting information resulting from the trend analysis is presented in Table 4.

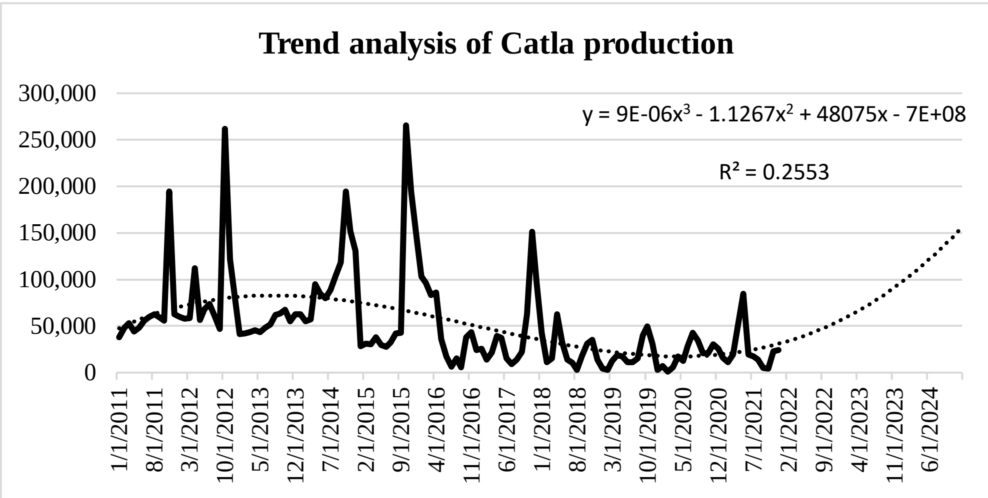

Figure 5: Trend analysis of Catla production in Udawalawe reservoir (Mt) from January 1, 2011 to December 31, 2021

According to the forecasting information derived from the trend analysis presented in Table 4, the months of November and December consistently exhibited the maximum level of Catla production. Conversely, the months of September and October were associated with the minimum level of Catla production. Additionally, there is a recession in Catla production reported during the time durations of February and March, as well as June and July.

Table 4: Forecasted Catla production (Mt) through the findings of the trend analysis for the time period of January 1, 2022 – December 31, 2024

Month	**Year**		
	2022	**2023**	**2024**
January	9770.6	4455.7	10976.7
February	9316.2	7659.6	7567.2
March	13695.8	15053.5	1577.9
April	16410.7	16805.5	18504.3
May	19775.2	22006.6	22367.4
June	1839.8	2817.2	2566.7
July	3103.7	6532.5	7340.5
August	4469.2	11518.2	27896.0
September	6348.0	608.6	3023.7
October	13891.7	15940.2	24545.8
November	18015.7	23270.7	25455.6
December	28126.5	24443.7	28672.2

Comparison of findings of the SARIMA model and trend analysis of the Catla production

Considering the findings of Table 3 and 4, it was evident that the forecasted Catla production information closely aligned with the Catla production information generated from trend analysis. However, it's worth noting that the SARIMA model findings (Table 3) appeared to be considerably more accurate than the Catla production information derived from trend analysis, particularly within a short time period. These findings validated the SARIMA model, as it provides more precise forecasts.

Additionally, the seasonal pattern of Catla production, characterized by a significant increase between October and December each year, further supported the accuracy of the SARIMA model. This contrasted with the trend analysis, which identifies September, October, and November as the peak Catla production periods. Therefore, the SARIMA model's ability to capture this seasonal trend reinforced its reliability and effectiveness in forecasting Catla production accurately.

Stationarity nature of Tilapia production series

The Dickey-Fuller test was conducted to determine the stationarity behavior of the Tilapia production information series. In this analysis, the hypothesis H_{0b} was employed. The results of this test are presented in Table 5.

H_{0b} There is no stationarity in Tilapia production information series from 2011 to 2021.

Table 5: Dickey fuller test – Tilapia production

Test for unit root in	Include in test equation	Co-efficient	Std error	t statistic	prob.*
Levels	Intercept	(-)0.191	0.051	(-)3.717	0.049
	Trend & intercept	(-)0.191	0.015	(-)3.719	0.024
1st Difference	Intercept	(-)0.983	0.088	(-)11.128	0.000
	Trend & intercept	(-)0.985	0.088	(-)11.102	0.000

**prob. < 0.005, stationarity was obtained in Catla production information series from 2011 to 2021.*

According to the findings presented in Table 5, the probability values of the unit root test for the Tilapia production information series were assessed considering two aspects: with intercept only and with both trend and intercept. The probability values for the unit root in levels with the intercept equation were noted as 0.049, and with the trend and intercept, it was observed as 0.024. Additionally, the probability values for the unit root in the first difference, including both intercept and trend & intercept, were reported as 0.000. With prob.* < 0.005, the null hypothesis (H0b) was rejected. Therefore, stationarity behavior was observed in the Tilapia production information series from 2011 to 2021.

Time series analysis of Tilapia production in Udawalawe reservoir

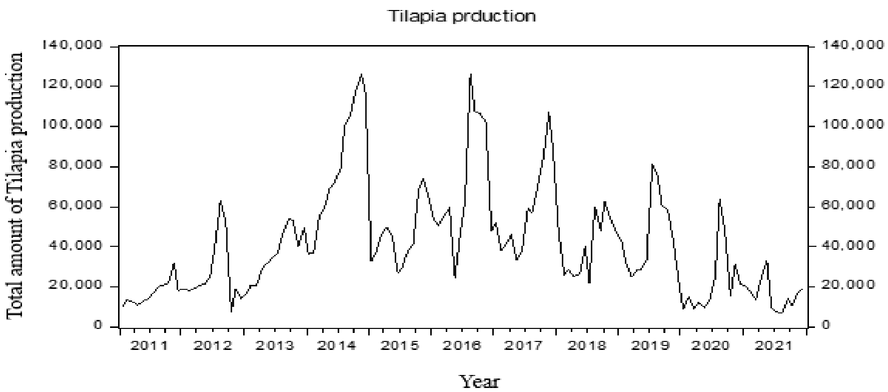

Figure 6: Tilapia production in Udawalawe reservoir (Mt) from 2011 to 2021

According to the results depicted in Figure 6, variations in Tilapia production were observed from the period of 2011 to 2021. The monthly Tilapia production information exhibited a noticeable increase in production between the months of August and November each year.

Based on the results of different models estimated, the chosen SARIMA model was identified as SARIMA (1,0,1) (1,1,1)12. Additionally, the selected SARIMA model demonstrated approximately equal values of Tilapia production statistics on a monthly basis, considering both actual and forecasted values of Tilapia production during the period from January 1, 2021, to December 31, 2024. A single order of difference was performed in the analysis.

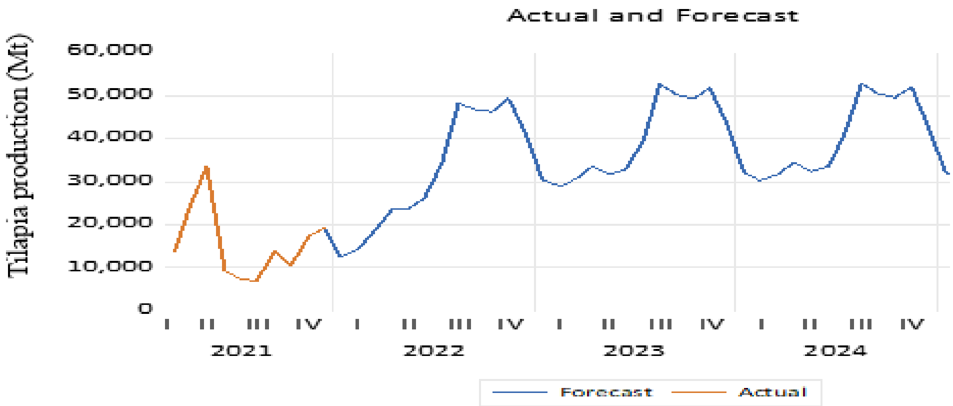

Figure 7: Actual and forecast graph of the Tilapia production in Udawalawe reservoir from January 1, 2021 to December 31, 2024

According to the findings illustrated in Figure 7, the selected SARIMA model demonstrated a close alignment between the monthly forecasted values and the actual values during the control time period from January 1, 2021, to December 31, 2021. This indicated a considerable level of precision regarding the monthly Tilapia production information between the forecasted duration of January 1, 2021, to December 31, 2024.

Monthly wise forecasted Tilapia production for the time period of January 1, 2021 – December 31, 2021

Table 6 presents the results of a comparison between forecasted monthly Tilapia production and actual Tilapia production on a monthly basis for the time period spanning from January 1, 2021, to December 31, 2021. Accordingly, the actual values of monthly Tilapia production and its seasonality closely matched the forecasted

Table 6: Forecasted Tilapia production (Mt) for the time period of January 1, 2021 – December 31, 2021

Month	Actual Tilapia production	Forecasted Tilapia production
January	20075	24840
February	16907	14345
March	13629	11722
April	24623	34327
May	33424	35910
June	9419	9832
July	7287	9145
August	7012	6698
September	14055	18367
October	10415	11782
November	17285	16980
December	19318	18603

Tilapia production for the given period. The forecasting of Tilapia production for the time period from January 1, 2021, to December 31, 2021, was conducted as part of the model validation procedure to assess the accuracy of the selected SARIMA model against the actual values. These findings validated that SARIMA (1,0,1) (1,1,1)12 was indicated as the most suitable model to forecast Tilapia production in the reservoir.

Monthly wise forecasted Tilapia production for the time period of January 1, 2022 – December 31, 2024

Table 7 shows the forecasted Tilapia production on a monthly basis for the time period spanning from January 1, 2022, to December 31, 2024. Accordingly, the actual values of Tilapia production and its seasonality closely align with the forecasted Tilapia production for the given period. Specifically, the months of January, February, March, and April, as well as October, November, and December, consistently exhibit the maximum level of Tilapia production

Table 07: Forecasted Tilapia production (Mt) through the findings of the SARIMA model for the period of January 1, 2022 – December 31, 2024

Month	Year		
	2022	**2023**	**2024**
January	47159.3	29478.4	26432.7
February	35289.9	36235.1	15992.1
March	31797.4	31872.8	11000.6
April	44352.2	44377.4	20327.5
May	25124.2	24338.8	9111.6
June	33778.7	33725.3	10233.6
July	55779.4	57414.1	22763.1
August	84717.5	87737.5	25507.4
September	69767.4	71167.0	29000.0
October	70458.1	72134.7	25668.0
November	71235.0	72490.2	32070.9
December	48489.1	48375.7	15467.8

Trend analysis of Tilapia production

Figure 8 presents the trend analysis findings of the Tilapia production in Udawalawe reservoir.

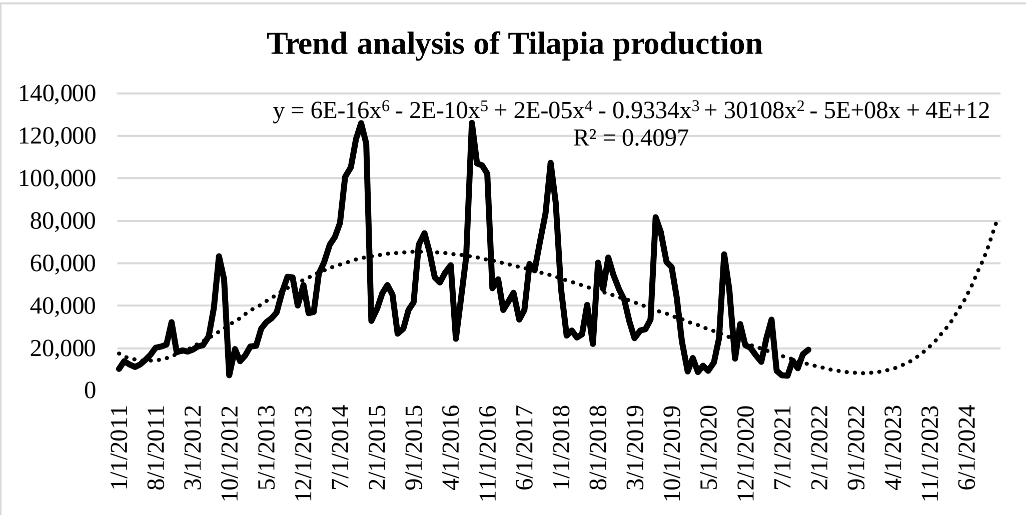

Figure 8: Trend analysis of Tilapia production in Udawalawe reservoir (Mt) from January 1, 2011 to December 31, 2021

According to Figure 8, a polynomial trendline pattern was observed for the graph of Tilapia production time series. The R-square value of the chart was reported as 0.4097, indicating a lower R-square value of 40.97% on the right of this curve. The forecasting information resulting from the trend analysis is presented in Table 8.

Table 08: Forecasted Tilapia production (Mt) through the findings of the trend analysis for the period of January 1, 2022 – December 31, 2024

Month	Year		
	2022	**2023**	**2024**
January	19159.3	25478.4	27432.7
February	35289.9	29235.1	36992.1
March	31797.4	31872.8	34000.6
April	24352.2	19377.4	24327.5
May	25124.2	20338.8	2511.6
June	33778.7	33725.3	31233.6
July	55779.4	57414.1	58763.1
August	64717.5	60737.5	61507.4
September	69767.4	71167.0	72000.0
October	70458.1	72134.7	25668.0
November	71235.0	72490.2	72070.9
December	48489.1	43375.7	45467.8

Based on the forecasting information derived from the trend analysis presented in Table 8, it was observed that the months of November, December, and January consistently exhibit the maximum level of Tilapia production. Conversely, the months of June, July, and August were associated with the minimum level of Tilapia production.

Comparison of findings of the SARIMA model and trend analysis of the Tilapia production

Considering the findings from Table 7 and Table 8, it was evident that the Tilapia production forecasting information closely corresponded to the Tilapia production information generated from trend analysis. However, the SARIMA model findings (Table 7) appeared to be more accurate than the trend analysis findings of Tilapia production information (Table 8) within a short time period. Furthermore, the SARIMA model findings indicated that the months of January, February, March, and April, as well as October, November, and December, consistently exhibited the maximum level of Tilapia production. This aligned with the trend analysis findings, which also identify these months as periods of higher Tilapia production in the Udawalawe reservoir. Additionally, the SARIMA model findings suggested that the months of May, September, October, March, and April exhibit higher levels of Tilapia production.

CONCLUSIONS

The SARIMA model has proven effective in forecasting both Catla and Tilapia production in the Udawalawe reservoir, with SARIMA (2,2,1) (1,0,1)12 being suitable for Catla production and SARIMA (1,0,1) (1,1,1)12 for Tilapia production. These models accurately capture the seasonal patterns in production, particularly noting the peak production months of October, November, and December for both fish species. The trend analysis also provides valuable insights, corroborating the SARIMA model findings to some extent. However, it seems that SARIMA models offer greater accuracy, especially when analyzing short time durations. Nevertheless, trend analysis can still provide valuable information, particularly in understanding long-term trends and patterns in fish production. Because, both Catla and Tilapia production exhibit significant changing patterns and multiple seasonalities. Thus, trend analysis gives valuable insights than SARIMA model in long term predictions in case of this study. Overall, these findings hold significant importance for enhancing fish production in the Udawalawe reservoir, as they provide valuable insights into seasonal variations and trends, allowing for informed decision-making and resource allocation in fisheries management.

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REFERENCES

Arthur, R. I., Skerritt, D. J., Schuhbauer, A., Ebrahim, N., Friend, R. M., & Sumaila, U. R. (2021). Small-scale fisheries and local food systems: Transformations, threats and opportunities. Fish and Fishires, 23(1), 109-124.

Athukorala, P.C., Ginting, E., Hill, H. and Kumar, U. (2017). The Sri Lankan economy : Charting a new course. Retrieved from http://dx.doi.org/10.22617/TCS178786-2

Bartley, D., Graaf, G. D., Valbo-Jørgensen, J. and Marmulla, G. (2015). Inland capture fisheries: status and data issues. Fishries Management & Ecology, 22(1), 71-77.

Deepananda, K., Priyadarshana, T., Lenarolle , W. and Udayantha, V. (2014). Indian carps reproducing naturally in Udawalawe reservoir, Sri Lanka. AACL Bioflux, 7(5), 333-341.

Department of Fisheries. (2020). Fisheries Statistics: 2020. Retrieved from https://www.fisheriesdept.gov.lk. accessed on 04th June, 2020.

FAO (2018). Review of the state of the world fishery resources: Inland fisheries. Retrieved from https://www.fao.org/3/ca0388en/CA0388EN.pdf Accessed on 26th May, 2022.

FAO (2020). Agricultural statistics in the Asia Pacific Region. Retrieved from http://www.fao.or/asiapacific/perspectives/agriculture/en.accessed on 08 th July, 2022.

FAO (2022). The state of world fishires and acquaculture: 2022. Retrieved from https://openknowledge.fao.org/server/api/core/bitstreams/6e614210-0433-48f7-a634-83264b58b3e5/content/sofia/2022/aquaculture-production.html accessed on 25th April, 2024.

Hayes, A. (2023). Understanding trend analysis and trend trading strategies. Retrieved from https://www.investopedia.com/terms/t/trendanalysis.asp

Herranz, E. (2017). Unit root tests. Wiley Interdisciplinary Reviews: Computational Statistic, 9(3), 1-20.

Mohsin, M., Memon, A. M. and Noman, M. (2017). Aquaculture in Pakistan: Status, opportunities and challenges. Indian Journal of Geo-Marine Sciences, 46(9), 1872-1878. Retrieved from: https://www.researchgate.net/publication/319306095

NAQDA (2021). Retrieved from: http://www.naqda.gov.lk/contact-us/. (Accessed on 24th May, 2023)

NAQDA (2023). Inland Fisheries and Aquaculture Performance-2022. Retrieved from http://www.naqda.gov.lk/news/Inland-Fisheries-and-Aquaculture-Performance-2022#:~:text=The%20Inland%20and%20Aquaculture%20production,100%2C930%20Mt%20compared%20to%202021.(Accessed on 26th April, 2024)

Premathilaka, L., Athapaththu, A. L., Perera, W. T., Haseena, M. A. and Wijesinghe, M. R. (2021). Changes in habitat coverage from 2005 to 2019 in the Udawalawe National Park, Sri Lanka. Ceylon Journal of Science, 50(4), 467-474.

Raman , R.K. and Das, B.K. (2018). Forecasting shrimp and fish catch in Chilika lake over Time series analysis. In C.-K. Ngan, Time Series Analysis - Data, Methods, and Applications (p. 130). doi:10.5772/intechopen.85458

United States of Agency for International Development [USAID]. (2009). Assessment of Aquaculture and inland fisheries in Estern Sri Lanka. Retrieved from https://pdf.usaid.gov/pdf_docs/Pnadt122.pdf