Analysis of Climate Change in Kalasin Province Using Artificial Intelligence Technology

KALASINPITTAYASAN SCHOOL
THE SECONDARY EDUCATIONAL SERVICE AREA OFFICE KALASIN

RESEARCHERS : MR.CHINNAKIT RITRUKSA ADVISOR : MR.CHUMPON CHAREESAEN

ABSTRACT

Climate change is a critical factor affecting agriculture, environment, and economy, particularly in climatically vulnerable regions such as Kalasin Province. This study aims to analyze temperature and rainfall trend changes in Kalasin Province between 2021-2024 and forecast trends until 2028 using Artificial Intelligence (AI) technology for climate prediction. The research utilized historical temperature and rainfall data from the Meteorological Department to train AI models, specifically Long Short-Term Memory (LSTM) and AutoRegressive Integrated Moving Average (ARIMA). The findings reveal a continuous increasing trend in Kalasin Province's temperature, particularly in the fourth quarter, with an increase of up to 3.12°C. Rainfall demonstrated significant variability, with some years showing a clear decline in early periods and increased precipitation during rainy seasons, potentially influenced by El Niño and La Niña phenomena. Comparing AI model performance, LSTM demonstrated higher accuracy than ARIMA, as evidenced by lower Root Mean Square Error (RMSE) values. The LSTM model showed superior capability in capturing data trends and variations. However, the models still exhibited limitations during periods of rapid climate changes. The study's results can serve as a foundational resource for climate adaptation planning, enabling relevant agencies to develop more effective measures for water resource and agricultural management in Kalasin Province.

GOAL OF PROJECT

- Analyze temperature and rainfall trend changes in Kalasin Province between 2021-2024
- Develop and evaluate AI model performance in predicting future climate changes
- Forecast climate change trends in Kalasin Province until 2028
- Analyze potential impacts on agricultural and environmental sectors

Introduction

Climate change represents a significant global challenge impacting ecosystems, economies, and human quality of life (IPCC, 2021), especially in ecologically vulnerable regions heavily dependent on agricultural sectors. Kalasin Province is one such area with high climate change risk, being a crucial agricultural region dependent on appropriate rainfall and temperature conditions (Meteorological Department, 2023). Currently, Artificial Intelligence (AI) technology plays a critical role in analyzing and predicting climate change trends by efficiently processing large datasets and identifying complex relationship patterns. This study aims to utilize AI models to analyze temperature and rainfall trends in Kalasin Province, generating knowledge that can inform appropriate future adaptation and mitigation strategies.

Experimental Procedure

date	Average Tempe	Minimum Temp	Maximum Tem	rainfall
2021-01-01	17.4	11.7	24.5	0
2021-01-02	18.5	12.3	25	0
2021-01-03	21	13.9	28	0
2021-01-04	22.1	16.6	28.3	0
2021-01-05	23.4	16.8	30.4	0
2021-01-06	23.7	18	29.5	0
2021-01-07	23.5	18	29.8	0
2021-01-08	20.6	14.7	26.1	0
2021-01-09	18	12.9	24.1	0
2021-01-10	18.4	12.4	25.2	0
2021-01-11	17.3	12.3	23.5	0
2021-01-12	15.5	10.8	21.8	0
2021-01-13	16.7	10.2	24.5	0

Data Collection

```
models = {}
histories = {}

# ดีกโมเดลและบันทึก
for col in target_cols:
    X, y = create_dataset(scaled_data[col], TIME_STEP)
    X = X.reshape(X.shape[0], X.shape[1], 1)

    # แบ่งข้อมูลเป็น train และ test
    train_size = int(len(X) * 0.8)
    X_train, X_test = X[:train_size], X[train_size:]
    y_train, y_test = y[:train_size], y[train_size:]

    model_path = os.path.join(MODELS_DIR, f"lstm_{col}.h5")

    # ถ้าโมเดลมีอยู่แล้ว โหลดมาใช้ต่อ
    if os.path.exists(model_path):
        print(f"Loading existing model for {col}...")
        model = load_model(model_path, compile=False)

        # Compile ใหม่
        model.compile(optimizer='adam', loss='mean_squared_error')
    else:
```

Train LSTM&ARIMA

```
# คำนวณ RMSE ของ LSTM
temp_lstm_rmse = np.sqrt(mean_squared_error(temp_test[time_steps:], lstm_temp_predictions))
rain_lstm_rmse = np.sqrt(mean_squared_error(rain_test[time_steps:], lstm_rain_predictions))
print(f"Temperature LSTM RMSE: {temp_lstm_rmse:.4f}")
print(f"Rainfall LSTM RMSE: {rain_lstm_rmse:.4f}")

# สร้างกราฟเปรียบเทียบผลลัพธ์
plt.figure(figsize=(12, 6))
plt.plot(temp_test.index, temp_test, label="Actual Temperature", color="black")
plt.plot(temp_test.index, arima_temp_forecast, label="ARIMA Forecast", linestyle="dashed", color="red")
plt.plot(temp_test.index[time_steps:], lstm_temp_predictions, label="LSTM Forecast", linestyle="dashed", color="blue")
plt.legend()
plt.title("Temperature Prediction: ARIMA vs LSTM")
plt.xlabel("Time")
plt.ylabel("Temperature")
plt.show()

plt.figure(figsize=(12, 6))
plt.plot(rain_test.index, rain_test, label="Actual Rainfall", color="black")
plt.plot(rain_test.index, arima_rain_forecast, label="ARIMA Forecast", linestyle="dashed", color="red")
plt.plot(rain_test.index[time_steps:], lstm_rain_predictions, label="LSTM Forecast", linestyle="dashed", color="blue")
plt.legend()
plt.title("Rainfall Prediction: ARIMA vs LSTM")
plt.xlabel("Time")
plt.ylabel("Rainfall")
plt.show()
```

Model Performance Evaluation&Future Trend Forecasting

Reference

- Meteorological Department. (2023). Thailand Climate Situation Report. Bangkok: Ministry of Natural Resources and Environment. https://tmd.go.th/media/PDF/tmdannual2023_com.pdf
- FAO. (2022). Climate Change and Agriculture. Rome: Food and Agriculture Organization. https://openknowledge.fao.org/server/api/core/bitstreams/f6270800-eec7-498f-9887-6d937c4f575a/content
- IPCC. (2021). Climate Change 2021: The Physical Science Basis. Geneva: Intergovernmental Panel on Climate Change.

RESULTS

Table 1: Climate Change Trends in Kalasin Province, 2021-2024

Quarter	Avg Temp (°C)	Min Temp (°C)	Max Temp (°C)	Total Rainfall (mm)
2021Q1	24.57	18.82	31.44	35.6
2021Q2	29.08	25.23	34.66	516.7
2021Q3	27.72	24.59	32.05	957.7
2021Q4	24.72	20.12	30.16	307.4
2022Q1	25.14	19.87	31.63	197.5
2022Q2	27.83	23.71	33.26	524.2
2022Q3	27.04	23.85	31.49	1133.9
2022Q4	24.62	20.02	30.22	211.0
2023Q1	25.01	19.44	31.53	20.1
2023Q2	30.01	25.54	35.72	523.0
2023Q3	27.74	24.55	32.18	1034.4
2023Q4	25.91	21.36	31.38	221.6
2024Q1	26.68	21.21	33.17	56.2
2024Q2	31.43	26.80	36.98	731.4
2024Q3	28.72	25.64	32.81	1034.5
2024Q4	26.20	21.30	32.20	111.9

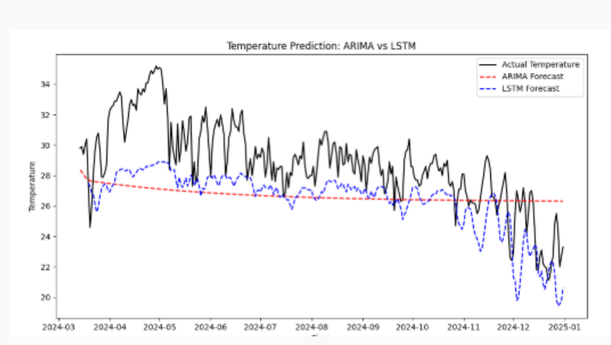

Figure 2: Comparison of Temperature Forecasts from ARIMA and LSTM Models with Actual Temperature Data

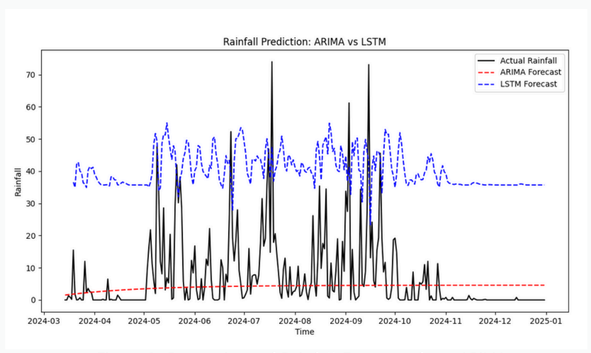

Figure 3: Comparison of Rainfall Forecasts from ARIMA and LSTM Models with Actual Rainfall Data

Model AI	RMSE value (°C)	RMSE value (mm.)
LSTM	2.95	12.24
ARIMA	3.29	35.35

Table 2: Comparison of AI Model Performance in Weather Prediction

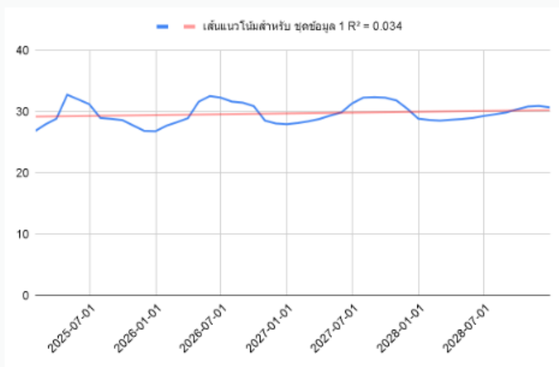

Figure 4: Temperature Trend Graph

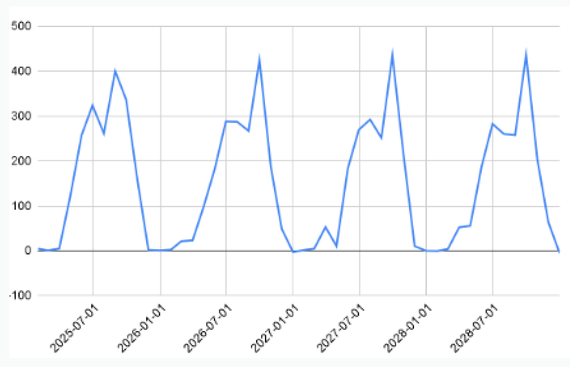

Figure 5: Rainfall Variation Graph

Quarter	Year 2025 (Temperature, Rainfall)	Year 2026 (Temperature, Rainfall)	Year 2027 (Temperature, Rainfall)	Year 2028 (Temperature, Rainfall)	Trend (Temperature, Rainfall)
Q1 (Jan-Mar)	26.90°C, 4.96mm	27.77°C, 2.72mm	28.22°C, 1.78mm	28.69°C, -0.38mm	Temperature: +1.79°C, Rainfall: -5.34mm
Q2 (Apr-Jun)	32.83°C, 121.22mm	31.68°C, 98.02mm	29.42°C, 10.46mm	28.87°C, 55.65mm	Temperature: -3.96°C, Rainfall: -65.57mm
Q3 (Jul-Sep)	29.03°C, 261.72mm	31.70°C, 287.67mm	32.36°C, 292.63mm	29.64°C, 260.45mm	Temperature: +0.39°C, Rainfall: -1.27mm
Q4 (Oct-Dec)	27.78°C, 157.30mm	28.61°C, 187.93mm	31.89°C, 210.86mm	30.90°C, 202.24mm	Temperature: +3.12°C, Rainfall: +44.94mm

Table 3: Forecasted Climate Conditions in Kalasin Province from 2025 to 2028 Using the LSTM Model.

CONCLUSION

This study aims to analyze the trends of temperature and rainfall changes in Kalasin Province using artificial intelligence (AI) technology for future weather forecasting and to compare the performance of different AI models in prediction. The findings indicate that the average temperature in Kalasin Province has shown a continuous upward trend from 2021 to 2024, with projections suggesting a further increase until 2028. The most significant rise is observed in the fourth quarter, reaching up to 3.12°C. Regarding rainfall, high variability is evident, with certain periods experiencing a decline. For instance, in the first quarter of 2028, rainfall is expected to drop to -0.38 mm. However, some years, particularly in the third and fourth quarters, show an increase in rainfall, possibly influenced by La Niña and the southwest monsoon, which can intensify precipitation during certain periods.

A comparison of AI model performance reveals that the Long Short-Term Memory (LSTM) model outperforms the AutoRegressive Integrated Moving Average (ARIMA) model in forecasting temperature and rainfall trends. LSTM demonstrates higher accuracy with a lower Root Mean Square Error (RMSE), indicating its superior ability to capture long-term data patterns. However, the LSTM model still has certain limitations, particularly in handling rapid weather fluctuations observed toward the end of the year.