CHAPTER V
CONCLUSION

5.1 Conclusion

Based on the results of research that has been carried out on the optimization of the Long Short-Term Memory (LSTM) algorithm using Particle Swarm Optimization (PSO) for rainfall prediction in Pasuruan Regency.

1. It can be concluded that the LSTM model was successfully built and implemented to predict daily rainfall in Pasuruan Regency using BMKG meteorological data from the Pasuruan Geophysics Station for the period January 1, 2021 to December 31, 2025. The data preprocessing applied includes data reconstruction and cleaning, handling missing value using Random Forest Imputation, data normalization using minmax scaler, and data transformation using sliding windows. The LSTM model built consists of two layers, hidden layers with input variables in the form of air temperature, air humidity, and rainfall.
2. PSO was successfully implemented to optimize the hyperparameters of the LSTM model through ten test scenarios that included variations in inertial weight (w), cognitive coefficient (c1), social coefficient (c2), particle count, and number of iterations. The optimization process involves finding the best combination for the four main hyperparameters of LSTM, namely, the number of neurons in layers 1 and 2, the learning rate, and the batch size. The best PSO configuration was found in the LSTM-PSO7 scenario with parameters w=0.9, c1&c2= 2.0, particle count and iteration of 10 each. The configuration resulted in an optimal LSTM hyperparameter with layer 1 neurons = 192, layer 2 = 103, learning rate = 0.009126, and a batch size of 16.
3. The best LSTM-PSO model has been proven to be able to produce better prediction performance than LSTM without optimization or other comparison methods. Based on the evaluation metrics that have been listed, LSTM-PSO7 is superior to all models that have been trained. These results confirm that the implementation of PSO makes a real contribution to

improving the accuracy of daily rainfall prediction in Pasuruan Regency. However, all deep learning-based models still have limitations in predicting extreme rainfall events that exceed 80mm per day. This condition suggests that the model still tends to predict rainfall that is too low at peak rainfall, so further development is needed to improve the model's ability to capture fluctuating rainfall patterns.

4. The last stage of this study is the implementation of a website-based model. This stage is proof that the model can be used and implemented in the form of a website. Some of the features contained in the rainfall prediction website are a dashboard to see the evaluation of models that have been designed and trained, a comparison graph between prediction models, and rainfall predictions with manual meteorological data input and predictions on the next day. The success in implementing the model into the website proves that the model is not only trained and evaluated, but can also be implemented applicatively.

5.2 Suggestions

Based on the research that has been conducted, there are several suggestions that can be improved for future research.

1. The addition of meteorological variables as input features needs to be considered to improve the model's ability to capture more complex atmospheric dynamics. Additional variables such as the duration of solar irradiation, wind direction, or global climate index have the potential to enrich the information available to the model so that rainfall predictions can be more accurate, especially in extreme rainfall events.
2. Expands the search range of hyperparameters by adding test scenarios for PSOs so that PSO configurations are more perfect. With a wider search space and a greater number of iterations, there is a possibility of finding more optimal hyperparameter combinations and resulting in lower fitness values.
3. Expansion of the coverage of the region and the period of data observation can strengthen the generalization of the developed model. Follow-up

research could consider the use of data from multiple meteorological stations in the surrounding region, as well as extend the observation period to include more diverse long-term climate variations. In addition, cross-regional validation can also be performed to test the model's adaptability to different local climatic characteristics.

4. The development of a web-based implementation system developed in this study can be continued with the addition of automatic and real-time data from BMKG, early warning notifications of hydrometeorological disasters, and integration with regional disaster systems. This will increase the practical value of this research as a decision-making tool in disaster risk mitigation in Pasuruan Regency.